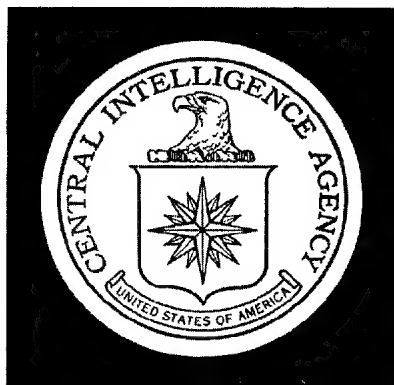


Top Secret

25X1



DIRECTORATE OF
INTELLIGENCE

Intelligence Memorandum

*The Rolling Thunder Program --
Present and Potential Target Systems*

JCS review completed. Secondary referral
to DIA.

Top Secret

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DIA review completed.

January 1967

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THE ROLLING THUNDER PROGRAM --
PRESENT AND POTENTIAL TARGET SYSTEMS*

Summary

This memorandum analyzes the effects achieved by the Rolling Thunder Program of air attacks on North Vietnam through 1966; it also estimates the probable effects which would be expected to ensue from restructuring Rolling Thunder in a variety of other ways, ranging from deescalation to substantial escalation. A summary of findings follows, with the details contained in Appendixes A through H.

* This memorandum was produced by CIA. Aside from the normal substantive exchange with other agencies at the working level, this memorandum has not been coordinated outside CIA. It was prepared by the Office of Research and Reports with a contribution from the Office of Current Intelligence. It was coordinated with the Office of Current Intelligence and the Special Assistant for Vietnamese Affairs; the estimates and conclusions represent the best judgment of this Office as of 31 January 1967.

I. Rolling Thunder in 1966*

The evidence available does not suggest that Rolling Thunder to date has contributed materially to the achievement of the two primary objectives of air attack -- the reduction of the flow of supplies to the VC/NVA forces fighting in South Vietnam or the weakening of the will of the Hanoi regime to continue with the insurgency. There is no doubt, of course, that Rolling Thunder has lowered the capacity of transport routes to the South, and hence put a lower "cap" on the force levels which could be supported in South Vietnam. However, it is estimated that the "cap" is well above present logistic supply levels.

Also, Rolling Thunder has not succeeded in materially lowering morale in the North. While there undoubtedly is some war weariness, the general indication is that the North Vietnamese people are behind the regime.

The North Vietnamese leaders continue to insist, both in public and private statements, that they are willing to withstand even heavier bomb damage rather than accept anything less than their often stated demands for a settlement in Vietnam. Hanoi has been able to adjust its military and economic activities, which support its war objectives, to the bombing. Hence, while there may be some degree of escalation that would force the regime to reexamine its position, it is believed that as far as pressure from air attack is concerned, Hanoi would be prepared to continue the insurgency in South Vietnam indefinitely in the face of the current level and type of bombing program.

The will of the regime to continue the war is heavily bolstered -- and this is a key factor -- by the relatively massive flow of economic and military aid from the USSR, China, and the Eastern European countries. A comparison of 1966 measurable damage in North Vietnam with aid deliveries is revealing:

	<u>Million US \$</u>	
	<u>Measurable Damage</u>	<u>Aid Deliveries</u>
Economic	94	275
Military	36	230
Total	<u>130</u>	<u>505</u>

* See Appendix A.

The fact that aid was almost four times the damage inflicted by air attacks not only gives Hanoi the muscle needed to strengthen the VC/NVA insurgency and its own air defense but also provides the services to overcome economic difficulties. Under these circumstances, it is concluded that Hanoi would be able and willing to persevere indefinitely in the face of the present Rolling Thunder program.

Air attacks have not eliminated any important sector of the economy or the military establishment. The successful attack on petroleum storage facilities eliminated 76 percent of the JCS-targeted national capacity, but the strikes did not come until after the North Vietnamese had already implemented a system of dispersed storage. The petroleum import flow has been maintained at adequate levels. The heavy concentration of the Rolling Thunder campaign on the lines of transportation south of Hanoi -- particularly Route Packages 1 and 2 -- has not succeeded in cutting route capacities to the point where the flow of supplies needed to support the expanded insurgency in South Vietnam has been significantly impeded.

The principal losses to the economy have been indirect and stem from reduction in agricultural output and the fish catch, the impairment of foreign exchange earnings through a cut in normal quantities of exported commodities, the cost of repairing essential transport facilities, and disruptions of production due to dispersal and other passive defense measures (see Figure 1).

Aircraft losses by North Vietnam amounted to an estimated \$17 million in 1966, while damage to SAM's, naval equipment, barracks, and other facilities has also been significant (see Figure 2). These attacks have disrupted normal military practices, caused the abandonment of many facilities, and forced widespread dispersal of equipment. However, the capabilities of North Vietnam's military establishment continue at a high level.

In 1966, the attack sorties flown against North Vietnam increased 217 percent over 1965 and the program became virtually an armed reconnaissance campaign (see Figures 3 and 4). Attacks flown against fixed JCS targets in 1966 (including armed reconnaissance restrikes) amounted to less than 3 percent of total attack sorties. About one-third of the 242 JCS targets remained unattacked; a large number of these represent powerplants, important industrial installations, and key transport targets. Most of the armed reconnaissance sorties were flown south of Hanoi, particularly in Route Packages 1 and 2

(see Figure 5). The cumulative damage to economic and military facilities is estimated at \$200 million of which \$130 million occurred in 1966. These data plus the cost of the attack are shown in Figure 6.

Preliminary estimates for civilian casualties in 1966 are about three times those in 1965, reflecting primarily the stepped-up level of attack. Military casualties in 1966 are below the level of 1965, largely because military barracks were heavily hit in 1965 but not in 1966. Estimated casualties are presented in the table.

Estimated Casualties from Rolling Thunder
1965-66

	<u>1965</u>	<u>1966 ^{a/}</u>	<u>Total</u>
Civilians	<u>6,000</u>	<u>17,900 to 20,200</u>	<u>23,900 to 26,200</u>
Fixed targets	2,000	900	2,900
Armed reconnaissance	4,000	17,000 to 19,300	21,000 to 23,300
Military	<u>7,200</u>	<u>4,650</u>	<u>11,850</u>
Fixed targets	4,300	400	4,700
Armed reconnaissance	2,900	4,250	7,150
Total	<u>13,200</u>	<u>22,550 to 24,850</u>	<u>35,750 to 38,050</u>

a. Preliminary estimates.

While these estimates are the best presently available and are believed to be the right order of magnitude, they are subject to error. The estimate for civilian casualties is more reliable than that for the military. The total casualties are small in relation to a total population of over 18 million, but losses have undoubtedly had a disruptive effect.

II. Alternative Target Systems

A. General

A number of alternative target systems have been examined in order to estimate the probable effects of their neutralization. These

alternatives include an attack on modern industry, the mining of the major ports and water entrances to North Vietnam, interdiction of the levees in the Red River delta, and an unrestricted bombing campaign with the exception of attacks against populated centers. These alternatives are discussed in detail in Appendixes B through E. In addition the effects of a reduced air campaign confined to Route Packages 1 and 2 and the infiltration network through Laos are discussed in Appendix F. The estimated casualties to be expected from these alternative programs are discussed in Appendix G. Finally, the effect of these programs on the will to persist of North Vietnam's leadership is discussed in Appendix H.

B. Modern Industry in North Vietnam as a Target System*

A review of modern industry in North Vietnam has resulted in the selection of 20 facilities for inclusion in this target system:

Seven electric power generating plants

One cement plant

One explosives plant and one potential
explosives material supplier

One rubber products facility

One chemical plant

Four engineering plants

One steel producing complex

Three coal processing plants

The neutralization of all these North Vietnamese industrial facilities would eliminate the fruit of several hundred million dollars in capital investment, cut off the source of perhaps one-quarter or more of the gross national product and most foreign exchange earnings, and could halt the construction of additional modern plants in North Vietnam by other Communist countries. It would also disrupt the functioning of other sectors of the economy through the loss of electric

* See Appendix B.

power and such materials as cement and some fertilizers and chemicals, add to the burden of aid from the Communist countries, and produce at least temporary displacement of the urban labor force.

A graduated, selective program beginning with air attack against all the facilities in one industry (such as all powerplants) probably offers a more promising vehicle for the application of pressure against the North Vietnamese regime than a widespread escalation against numerous industrial targets in a variety of industries. Such a program not only would maximize the economic and military impact of the attacks but also would provide Hanoi with a continuing opportunity for second thoughts. If Hanoi failed to react, the completion of the total program would deal a serious blow to North Vietnam's hopes for economic progress and status, negating a decade of intense effort devoted to the construction of modern industry.

There are two factors which are important to keep in mind in considering the effects of any escalated program of air attack:

(a) The North Vietnamese leadership has been making an even greater effort than usual over the past two months to prepare the people of North Vietnam for further sacrifices during 1967.

(b) The will of the North Vietnamese to persist in the war depends not only on the effect of the air-strikes in the North but also on how they assess the war situation in South Vietnam.

While severe damage to the modern industrial sector would place additional pressures on the regime, it is not believed that this burden by itself would be intense enough to bring Hanoi to negotiate. The most relevant evidence -- the neutralization of much of the heavy industry in North Korea during the Korean War -- would suggest that the burden would be bearable.

Modern industry in North Vietnam -- machinery, chemical, fertilizer, cement, and electric powerplants -- makes a contribution to the military capability of the North Vietnamese and Viet Cong forces in South Vietnam and/or to the air defense capability in the North, but this contribution is not vital. The essentially agrarian nature of the

economy together with numerous local and handicraft facilities, which reportedly meet 70 percent of the population's demand for consumer goods, provides a strong buffer against economic collapse.

The deficit of essential economic goods needed to sustain North Vietnam's economy and the military supplies which are vital to the country's air defense, as well as to the maintenance of large-scale aggression in South Vietnam, come from other Communist countries. In the absence of an effective program for the interdiction of the transport system, it is expected that the flow of imports would increase. A successful air attack on all of the modern industry facilities listed above would increase import requirements well above present levels. The combined current capacities of the sea and land routes leading to North Vietnam could sustain the flow.

The experience in the Korean War -- the most relevant one for comparison -- suggests that the loss of modern industry may not be a decisive factor, by itself, in critically reducing the will to persist, at least as long as the abundant flow of war-supporting supplies continues.

C. The Mining Program*

Two alternative mining programs were examined. The first is a conventional mining program designed to prevent the use of deep-draft oceangoing ships but lacking a capability to prevent the use of shallow-draft craft such as coasters and lighters. The second alternative is a program using a newly developed mine with a capability against shallow-draft shipping.** Both mining programs assume the use of intensive armed reconnaissance against lines of communication and transport targets in order to maximize the potential effects of the program.

The interdiction of the port of Haiphong would cause serious concern to the Hanoi leadership. Their reaction would depend on the effectiveness of the mining and the success of alternate methods of supply. As long as North Vietnam believed that it could receive essential supplies, its resolve to fight on would probably remain.

* See Appendix C.

** This mine is the MK 36, a modification of the standard MK 82 aerial bomb, which is effective against even unpowered small craft in depths up to 50 feet. It can be delivered by all aircraft capable of using the MK 82, and requires the same delivery techniques as the MK 82. The MK 36 is to go into mass production in the spring of 1967.

The North Vietnamese could probably continue to supply the Viet Cong, the air defense system and essential war-supporting activities in the North with supplies for a while, using current stockpiles and imports, even in the face of a reduced flow over Communist China's road and connecting rail system. However, should the logistic pinch become severe enough to deplete stocks in North Vietnam, the chances of a reexamination by Hanoi of its whole approach to the war would increase markedly.

The immediate impact of either mining program would be a disruption of normal transport activity ranging from a situation in which a substantial portion of imports could be maintained by sea and coastal water movement to one of almost complete denial of water access to North Vietnam.

Either mining program would have serious disruptive effects on the North Vietnamese transport system and the effectiveness with which it accommodates the movement of foreign trade. Almost all export trade would cease and foreign exchange earnings would become negligible. It is estimated, however, that unless the rail and road lines to China were interdicted, surplus transport capacity and adequate equipment would exist, and hence North Vietnam will attempt to maintain the flow of virtually all normal imports plus the new import requirements generated by the attacks on modern industry. Thus the effects of the mining program will tend to be those of delay but not denial of imports.

A mining program directed solely against oceangoing shipping would increase the traffic burden on the major rail connections to Communist China to the extent that North Vietnam would be hard pressed to meet all normal traffic requirements by using rail connections, but the traffic could be handled by resorting to road and inland water routes.

A program including mining of coastal and inland waters would be much more effective. North Vietnam would have to rely almost completely on the existing road and rail connections to Communist China and use them at or near capacity levels. If intensive interdiction and armed reconnaissance were carried out against these vital transport links, North Vietnam would face increasingly serious problems. The vulnerability of transport equipment, the difficulties of maintaining lines of communication, and the cost and unreliability of transport would all increase significantly. Some import programs would almost certainly have to be reduced. These problems alone

would not be sufficient, however, to degrade meaningfully the flow of essential military materials or to prevent North Vietnam's continued support of the war in the South.

D. Interdiction of the Levees in the Red River Delta*

The rice fields and populated centers of the delta are protected by an elaborate system of levees which have greatly reduced flooding from natural causes. Damage to the rice crop -- the staple food in North Vietnam -- would be maximized if these levees were breached when the Red River is at its height, some time in the period mid-July to mid-August.

The areas most vulnerable to flooding, if the primary levees of this system were breached, are the Ha Dong area southwest of the Red River and the Ha Bac area northeast of the river. If only the main levees were breached, it is estimated that the crop loss would be on the order of several hundred thousand tons of rice -- over 5 percent of the annual production of rice. If the secondary levees were also effectively breached, the decrease in rice production could reach a million tons, or over 20 percent of annual production.

To mitigate the effects of the flooding, Hanoi would be forced to divert a very sizable work force away from other activities, including those of a military supporting nature, for a period of weeks until the major damage had been repaired.

A successful attack on the levee system at Ha Dong would be exceedingly disruptive in the short run. There are probably 1.5 million people in the Ha Dong area, including Hanoi. This Agency has not made an independent study of the probable level of casualties; military target studies estimate they would be small, numbering in the hundreds rather than thousands. Homes in the village areas would be destroyed, and factory activity would be halted. Over the long run, the effect on rice availabilities would probably be the hardest problem for the regime. The loss of at least several hundred thousand tons, and perhaps a million tons, of rice, particularly in a year of below-average harvests, would force Hanoi to seek outside sources of supply. Communist China, which in an average year produces 75 million to 85 million tons of rice, could provide the necessary amount.

If the effects of the attacks on modern industrial targets and the mining program were at maximum levels, the attack on levees

* See Appendix D.

would increase North Vietnam's cumulative import requirements from the present level of 4,200 tons a day to a total of from 6,100 to 8,000 tons a day. The transport capabilities of North Vietnam in this situation would fall short of maximum requirements by 15 to 20 percent. Their ability to sustain imports would be influenced strongly by the effectiveness of interdiction programs against the road and rail connections to China.

If an interdiction campaign reduced the capacity of the rail lines on a sustained basis by only one-third and of the road systems by only one-fourth, the available route capacity would then be only 6,400 tons a day. The rail cut could be sharper than one-third; the road cut represents the maximum interdiction sustained to date in North Vietnam. The North Vietnamese would then be hard-pressed to move even their minimum import requirements. If the interdiction program were even more successful, the regime would face increasingly severe problems. Hard decisions would have to be made about the imports which could be forgone and a system of more rigorous rationing would probably become necessary. More importantly the continuity and reliability of the flow of essential military and economic assistance from the USSR and Communist China would become a matter of highest concern.

Since the major burden of a successful attack on the levees would fall on the civilians in agricultural areas, there probably would be a highly adverse public reaction in the West. This criticism would be more strident than that which would be expected from attacks on any other target system, with the possible exception of raids on population per se. The military effects of "levee busting" would probably be both limited and short lived; the effect on the Hanoi regime's will to continue would be marginal.

Hanoi's reaction to strikes on the Red River levees would depend on the damage done by the strikes, the effectiveness of the regime's countermeasures, and Hanoi's ability to obtain food from China and the USSR. The Hanoi leaders probably believe that North Vietnam can localize damage from attacks on the dike system and that the attacks will not limit their abilities to persist in the war. The North Vietnamese would certainly exploit the golden opportunity presented by such attack in their propaganda effort to put intense political pressure on the United States.

E. An Unlimited Bombing Campaign*

The major thrust of an unlimited bombing campaign following the previous alternatives would be against transportation and military targets and a small number of economic targets.

1. Transportation Targets

Although the transportation system has been a major target since the inception of the Rolling Thunder program, the weight of the bombing effort has fallen on Route Packages 1, 2, and 3, where military and economic requirements for traffic movement have been relatively small in relation to route capacity. Hence, despite the weight of attack, the North Vietnamese have been able to keep essential supplies flowing.

The basic concept of an unlimited attack on transportation would be to take advantage of the two major factors which emerge from the bombing campaigns outlined earlier. First, a higher import requirement -- ranging from 6,100 to 8,000 tons -- would result from the neutralization of most production facilities and, second, North Vietnamese ports and the inland waterway system would be closed, or nearly closed, by mining. Under these circumstances, the remaining rail and road connections to Communist China would be forced to operate at -- or virtually at -- capacity. An analysis of North Vietnam's transport capabilities leads to two conclusions:

(a) The uninterdicted capacity of the roads and the rail lines, allowing sufficient time to organize the necessary truck transport, would probably be sufficient to transport the required daily tonnages in full to North Vietnam, even if the ports were mined.

(b) Given a successful interdiction campaign, the net capacity of the roads and the rail lines would be insufficient to satisfy the maximum daily requirement and, therefore, some reduction in the desired levels of supplies would take place.

* See Appendix E.

If an unlimited interdiction program were highly successful, the regime would encounter increasing difficulty and cost in maintaining the flow of some of their most essential military and economic goods. In the long term the uncertainties and difficulties resulting from the cumulative effect of the air campaigns would probably cause Hanoi to undertake a basic reassessment of the probable course of the war and the extent of the regime's commitment to it.

2. Other Potential Targets

In addition to industrial-economic targets, there are a number of military facilities presently on the JCS target list whose neutralization would be of importance in blunting the military capabilities of North Vietnam. The most prominent of these are 11 airfields. There are also a number of barracks and smaller military supply depots widely dispersed throughout North Vietnam. In an unlimited campaign these facilities presumably would be taken under attack.

Other potential targets include such varied installations as a number of primary radio communications centers, the six plants constituting North Vietnam's pharmaceutical industry, transport repair facilities, textile plants, food-processing plants, and fertilizer plants. Neutralization of these targets would cause further disruption of economic and military activity in North Vietnam. But the principal gain to be expected by taking them under attack is that their neutralization would increase North Vietnam's import requirements and aggravate further their difficult problems in logistics and distribution.

Air attacks on the miscellaneous industrial and repair facilities in the "unlimited" package would probably bring only marginal additional pressure on Hanoi unless the attacks significantly impeded the flow of essential war-supporting supplies and equipment currently flowing in from the USSR, China, and other Communist countries.

F. Restriction of Rolling Thunder to Route Packages 1 and 2 and Laos*

About 60 percent of all airstrikes in North Vietnam and Laos during 1966 were carried out against targets in the "logistic funnel" which comprises Route Packages 1 and 2 in North Vietnam and the road network through the Laotian Panhandle. The total effort in these

* See Appendix F.

three areas during the first 11 months of 1966 amounted to about 68,000 attack sorties delivering about 112,000 tons of ordnance to the target area. Despite this effort, the level of supplies currently needed to support the VC/NVA forces fighting in the South has continued.

Concentration of all air attack forces on the "logistic funnel" would increase by about 60 percent the bombing program in this area, raising the level of ordnance expended from 10,000 tons to around 16,000 tons per month. In a short time the North Vietnamese would respond to the intensified bombing by increasing the size of the labor force engaged in repair work. The estimated requirement of a 30 percent increase in repair and reconstruction manpower could be drawn from areas of North Vietnam no longer being bombed and would be made up of experienced repair crews. Moreover, their air defenses in the "funnel" also would be strengthened to aid in countering the intensified bombing program.

If the Rolling Thunder program were cut back to an interdiction campaign against Route Packages 1 and 2 plus Laos, Hanoi would regard the limitation as a clear victory. They would see it as evidence that political pressures on the United States as a result of the reaction to propaganda claims about civilian casualties inflicted further north had been effective. The regime would be encouraged in its belief that the United States will ultimately tire of the war and that its policy was forcing the United States to retreat.

A similar program to reduce the logistic capacity of the Communists, called Operation Strangle, was carried out during the Korean War with only limited effectiveness. A strip across North Korea 60 nautical miles in depth was bombed day and night for 11 months in an attempt to cut off supplies needed by the Communist armies. By means of a system of countermeasures very similar in scope to those now being carried out by the North Vietnamese, the Communists greatly reduced the effectiveness of the US bombing program while at the same time continuing to provide the necessary supplies for their war effort.

G. Estimated Casualties Resulting from Alternative Rolling Thunder Programs*

The alternative Rolling Thunder programs examined in this report would tend to yield casualties at a significantly higher rate than that observed in 1966. This arises principally because these programs tend to be centered on targets located in the more heavily populated

* See Appendix G.

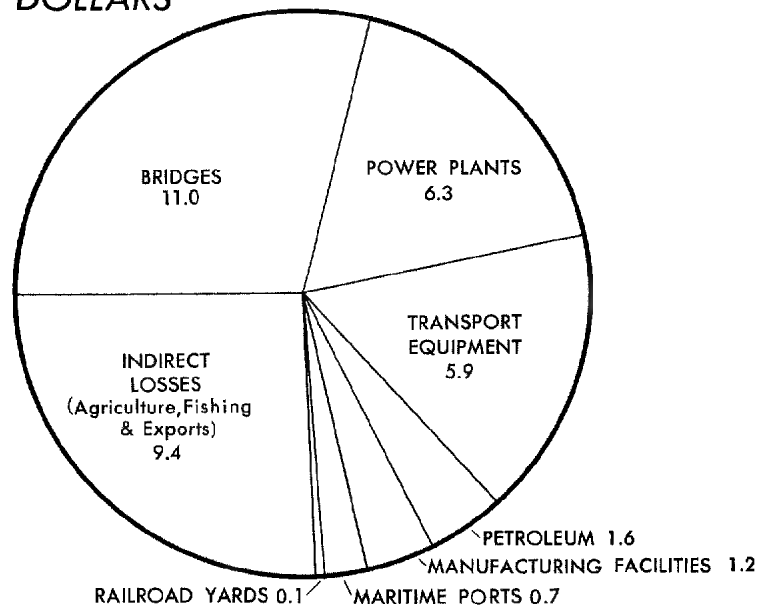
areas of North Vietnam. Specific numbers of casualties could not be estimated for every aspect of each campaign, particularly armed reconnaissance programs. A rough approximation indicates, however, that total casualties resulting from attacks on fixed targets could range from 15,000 to 20,000. Approximately one-third of these would be civilian casualties, most of whom would have been engaged in war related activities. Casualties in this amount -- if they were all sustained in 1967 -- would be at a level from two to three times higher than that obtained by attacks on fixed targets in 1965 and 1966 combined.

Armed reconnaissance in 1966 accounted for about 95 percent of total casualties. If the alternative bombing programs are carried out by cutting back significantly on armed reconnaissance programs in the areas south of Hanoi, there probably would be a marked decline in the number of casualties from this source. In this event the total casualties resulting from the alternative programs might not be significantly greater than the total casualties inflicted during the 1966 campaign.

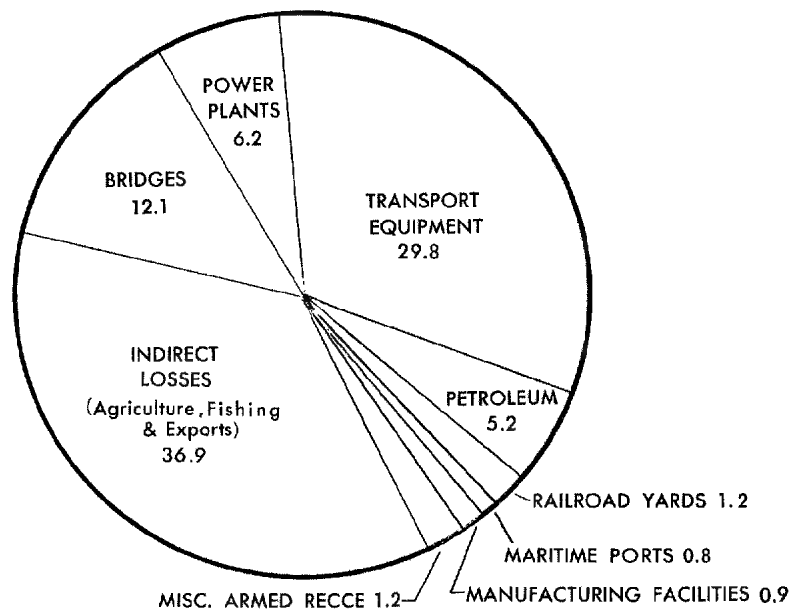
ECONOMIC DAMAGE

MILLION US DOLLARS

1965
36.2



1966
94.3



65560 1-67 CIA

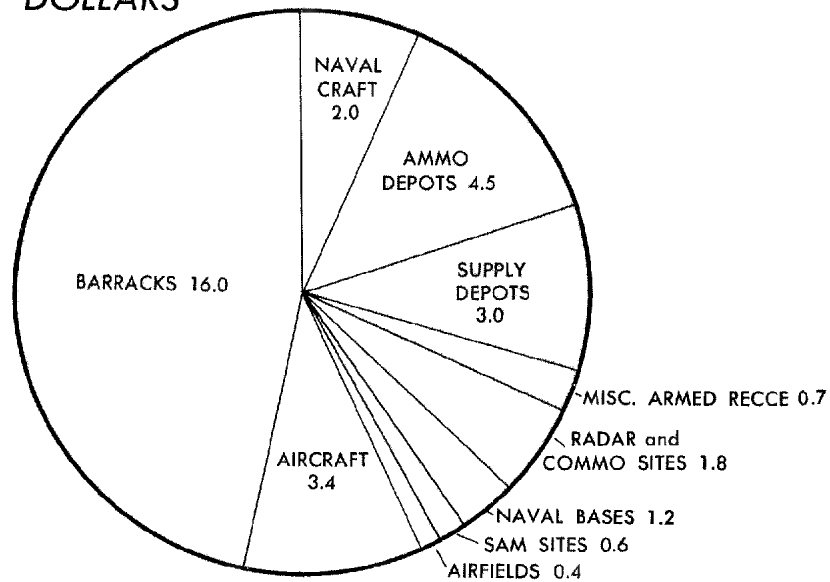
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Figure 1. Value of Economic Damage in North Vietnam, by Sector, 1965 and 1966

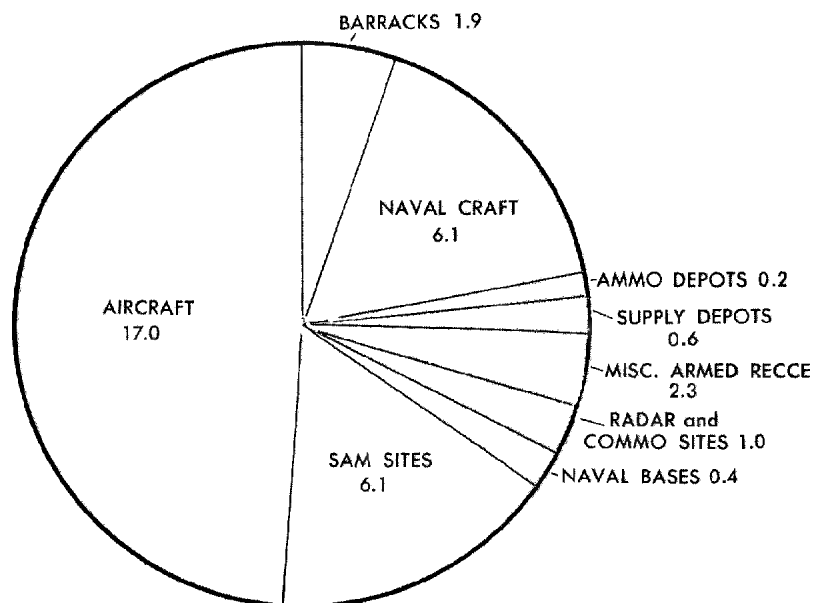
MILITARY DAMAGE

MILLION US DOLLARS

1965
33.6



1966
35.6



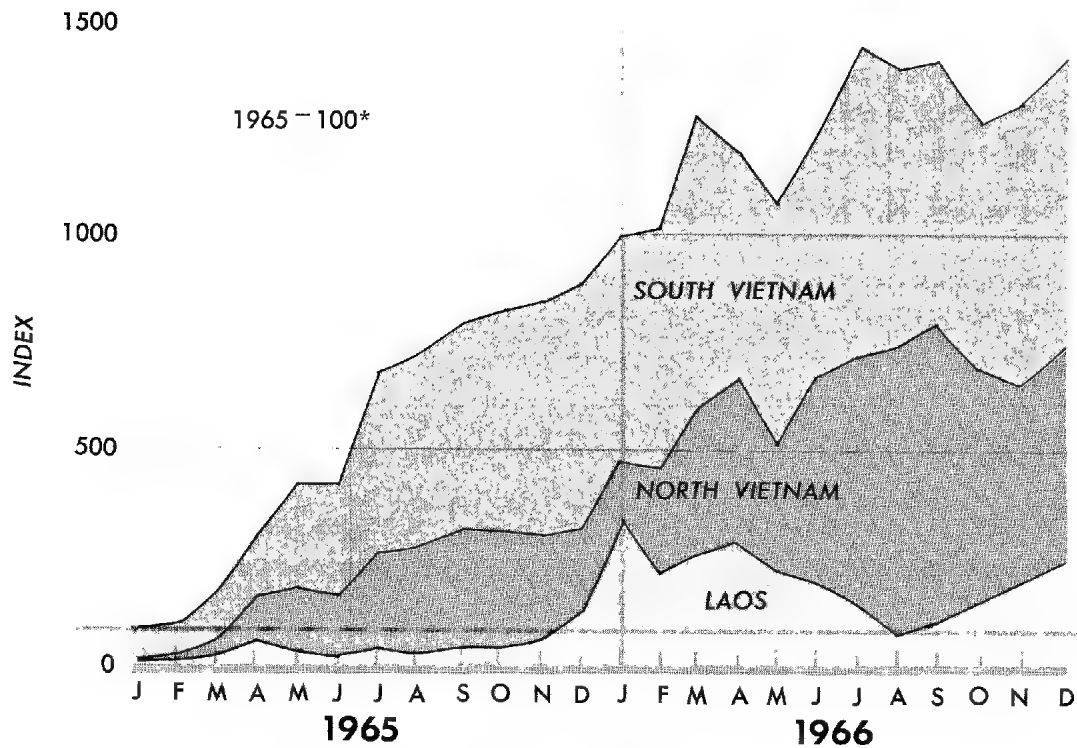
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Figure 2. Value of Military Damage in North Vietnam, by Sector, 1965 and 1966

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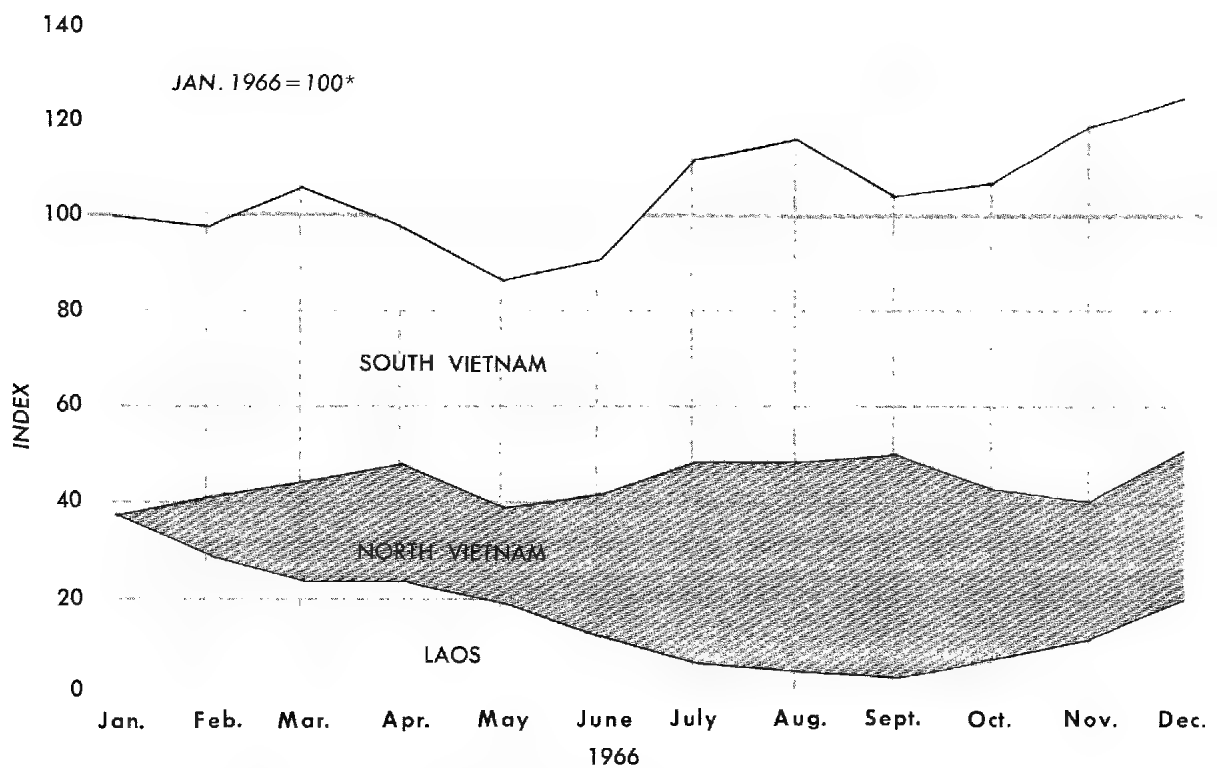


*January 1965 total for Laos, North Vietnam, and South Vietnam

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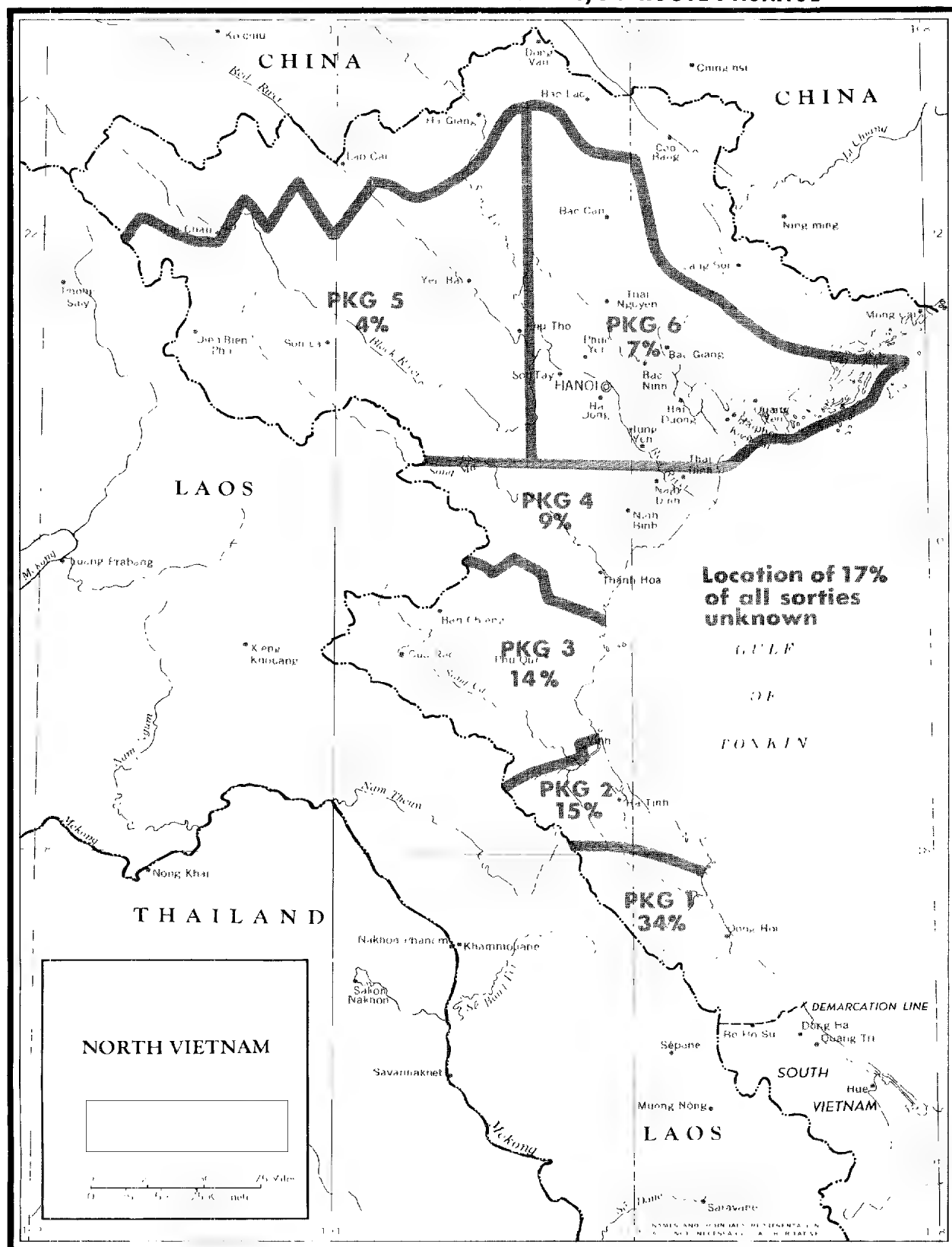
ORDNANCE DELIVERED



65563 1 67 CIA

Figure 4. Index of Ordnance Delivered in Southeast Asia and Relative Amounts in Each Area, 1966

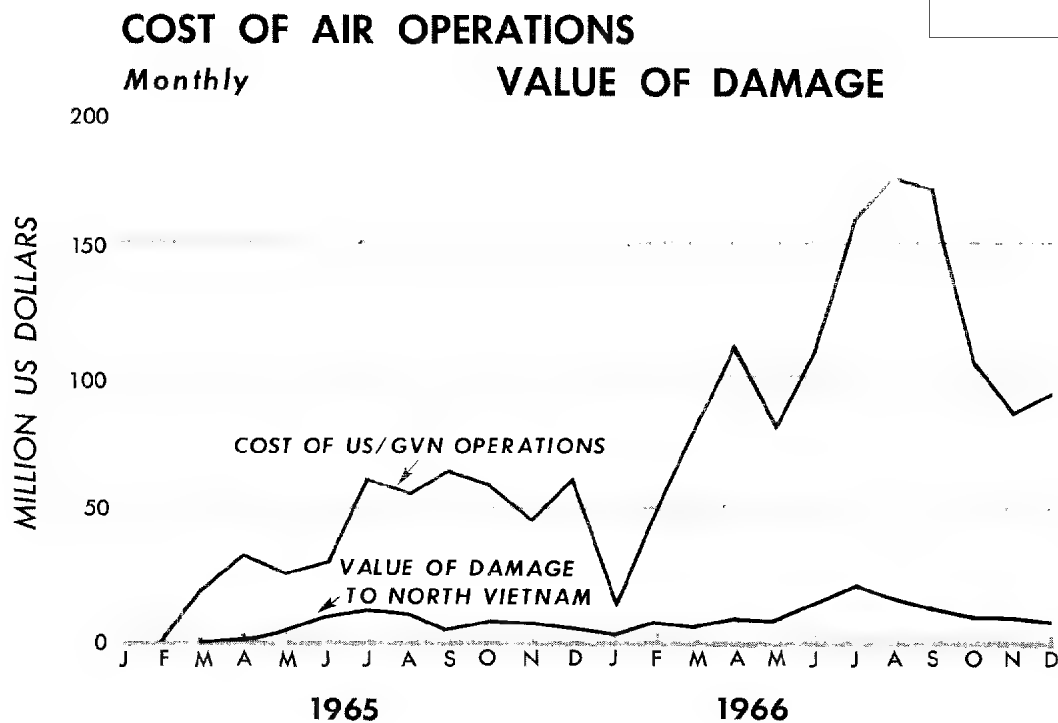
AVERAGE DISTRIBUTION OF US SORTIES, BY ROUTE PACKAGE



65564 1 67 CIA

Figure 5. North Vietnam: Average Distribution of US Sorties, by Route Package, January - November, 1966

25X1



65565 1 67 CIA

Figure 6. Estimated Direct Operational Cost of US/GVN Air Operations in North Vietnam and Cost of Economic and Military Damage to North Vietnam, by Month, 1965 and 1966

APPENDIX A

AN APPRAISAL OF THE ROLLING THUNDER PROGRAM

I. Physical Effects

A. Overall

The cost of reconstruction or repair of the economic and military facilities in North Vietnam which have been attacked under the Rolling Thunder program during 1965-66 is estimated at about \$200 million. About 65 percent of the damage was inflicted on economic targets and 35 percent on military targets. The damage inflicted during 1966 represents \$130 million of the total.

Damage to the economy accounts for more than 70 percent of the total in 1966, whereas in 1965 economic loss represented only about 50 percent. Indirect losses caused by shortfalls in agriculture, fishing, and exports accounted for nearly 40 percent of the total economic damage in 1966, and destruction and damage to transport equipment accounted for a little more than 30 percent. Bridges, powerplants, and petroleum storage sites were the principal categories of targets responsible for the remainder.

More than 80 percent of all military damage in 1966 resulted from attacks on aircraft, naval craft, and SAM sites, but in 1965 the damage from such attacks amounted to less than 20 percent of the total. Damage to barracks made up nearly one-half of the total damage to military targets in 1965 but only a small portion of the total during 1966.

The greatest amount of damage inflicted in 1966 occurred in the months of June through September, the peak month being July. During these months the attacks on bulk petroleum storage began, and major losses in naval craft, aircraft, and transport equipment occurred. Damage to bridges also reached a peak in July. Indirect losses were at their highest point in June. During 1965 the monthly trend in physical damage was generally similar to that in 1966.

The measurable effects in the major target systems are discussed in the following sections.

B. Economic Targets*

1. Petroleum Storage

On 1 January 1965 there were 13 fixed (JCS) petroleum storage targets with a combined storage capacity of almost 128,000 tons. ** Some 26,000 tons of capacity -- about 20 percent of the total capacity on 1 January 1965 -- was destroyed by attacks during 1965. The value of the tankage and contents and the related support facilities destroyed in 1965 is estimated at \$1.6 million.

During 1966, about 77,000 tons of capacity -- about 60 percent of the total existing on 1 January 1965 and 75 percent of the total on 1 January 1966 -- was destroyed. The value of the tankage and contents and the related support facilities destroyed in 1966 is estimated to be between \$4.5 million and \$5.2 million. ***

Total residual capacity at the nine fixed petroleum storage targets remaining on 31 December 1966 was about 26,000 tons. There was no indication that any of the attacked sites were being restored or reconstructed as of 31 December 1966. There was evidence, however, that parts from the moderately damaged tanks at Haiphong were being salvaged.

In addition to the capacity of the JCS-targeted facilities, the North Vietnamese have developed additional capacity in dispersed tank sites. By 31 December 1966, more than 100 tank sites with a total estimated capacity of between 30,000 and 40,000 tons probably existed.

* This appendix is based on a detailed statistical analysis of each major target system, the attacks leveled against it, the extent of damage to the system, and the cost of restoration or repair. These statistical summations are not published in the report but are available in the Office of Research and Reports.

** Additional tankage of about 5,400 tons existed on 1 January 1965 but was subsequently removed. The present whereabouts of this tankage is unknown. This tankage was not affected by bombings and is not now carried as usable capacity; therefore, it is excluded from all calculations.

*** The range in value is necessary to reflect the possible range in the amount of petroleum in the tankage that was damaged or destroyed.

Additional storage capacity is represented by the "55-gallon" drums dispersed throughout the country. It is estimated that about 170,000 drums, representing a capacity of 28,000 tons, had arrived in North Vietnam by 31 December 1966. During 1966, there were more than 1,200 strikes against about 450 identified or suspected dispersed petroleum storage sites, consisting of small tanks and drums. It is estimated that these strikes may have resulted in the loss of as much as 5,000 tons of storage. The restoration cost of these tanks, drums, and their contents and appurtenances as well as other petroleum storage facilities for which no meaningful bomb damage assessment is available may amount to about \$400,000.

The total cost of the damage inflicted by airstrikes during 1965 and 1966, therefore, is in the range of \$6.5 million to \$7.2 million.

2. Electric Powerplants

Attacks on North Vietnam's electric power facilities since April 1965 have put out of operation 59,000 kilowatts (kw) of power-generating capacity, almost 32 percent of the national total. In addition, the attacks have prevented 24,000 kw of new capacity from being put into operation. The total cost of restoring damaged power facilities is estimated at \$12.5 million, of which \$6.2 million is the estimated value of damage inflicted during 1966.

Although airstrikes have put out of operation about one-third of the generating capacity in North Vietnam's electric power industry, the losses of power-generating capacity probably have had only a minor effect on the economy and on the ability of North Vietnam to conduct military operations. Remaining capacity has been adequate to supply most industrial consumers and probably even to supply minimal nonindustrial demands. There have been reports of occasional power shortages in Hanoi and Haiphong involving nonindustrial consumers, but no reports concerning restrictions on power supplied to industry. The major part of modern industry in North Vietnam is concentrated in and around these two cities. Shortages in the Hanoi-Haiphong area probably have made it necessary to discontinue service only to nonessential users during peak-load periods. The most severe shortages of power to industry are estimated to have occurred at Nam Dinh, Thanh Hoa, and Ben Thuy. It is possible that lack of a reliable source of power was a factor in the decision to disperse parts of the Nam Dinh textile mill.

North Vietnam has made some slow progress in restoring damaged power facilities. Repair work at the Nam Dinh powerplant had progressed to a stage in October that indicated possible partial operation of this plant by the end of 1966. Restoration under way at the Thanh Hoa and Ben Thuy plants was nullified by airstrikes during September and October. There has been no attempt to repair the damaged powerplants at Co Dinh* or at Ban Thach since mid-1965. The Uong Bi powerplant was put back into service after the strikes of December 1965 and April 1966, and work toward restoration apparently has been started again since the heavy destruction inflicted in August 1966.

The persistence of efforts to restore damaged power facilities underlines the importance of these plants to North Vietnam and strongly suggests that no suitable alternative to central generating plants has been found. Mobile generating units imported by the hundreds during the past 18 months apparently have failed to offset the loss of central generating facilities.

3. Manufacturing

Only four manufacturing facilities of any significance have been attacked under the Rolling Thunder program during 1965-66, two of which were struck in 1965 and two in 1966. In addition, one of the facilities hit in 1965 was restructured in 1966. Although restoration costs are estimated to be comparatively small for damage to these plants in either year (\$1.2 million in 1965 and \$900,000 in 1966), losses in production from these plants appear to be considerably more significant.

The two plants attacked in 1965 were the Lang Chi Explosives Plant and the Nam Dinh Textile Mill. Neither plant has been restored, and presumably greater imports are compensating for the loss in production from these plants. The Nam Dinh Textile Mill is in only limited operation, but an undetermined and perhaps significant share of its capacity is believed to have been restored by the subsequent relocation of much of the mill's equipment to dispersed locations.

In 1966 the Cam Pha Coal Treatment Plant was attacked twice in April (as part of the attacks on the Cam Pha Port complex) and reportedly again in November. Damage at Cam Pha resulted in

* Additional damage on the Co Dinh plant by a November strike rendered the plant virtually a total loss.

a considerable reduction in coal exports, amounting to about \$4.7 million through December 1966. The Viet Tri Paper Mill (not a JCS target) was attacked in July and reportedly again in November. It is estimated that the plant, which represents 80 percent of the national capacity, will be inoperable for a long time.

A few additional manufacturing plants, which are believed to be small, are reported to have been damaged during 1965-66. These include a spinning cooperative, a silk mill, and a farm implement plant, all in Nam Dinh. The Eighth of March Textile Mill, a large mill in Hanoi, also received negligible damage from an exploding rocket during an airstrike mission in December 1966.

4. Bridges

The total number of bridges confirmed by photography to have been damaged or destroyed by the Rolling Thunder program increased slightly in 1966 compared with 1965. The estimated cumulative cost of complete restoration to the original condition through 1966 is \$19.0 million, compared with \$10.1 million in 1965. Cumulative estimated costs to make temporary repairs to those bridges still unrepaired at the end of 1966 would be \$1.3 million. In addition, at least \$2.8 million has been actually expended through 1966 for temporary repairs to bridges. Cumulative costs, assuming both temporary repairs and complete restoration of bridges, will be \$23.1 million for damage inflicted through 1966, compared with \$11.0 million for damage inflicted through 1965.

a. JCS-Targeted Bridges

Attacks against JCS-targeted bridges increased slightly in 1966, compared with 1965, but the number of such bridges attacked was slightly less than the total in 1965, as shown in the following tabulation:

	<u>Attacks Against JCS-Targeted Bridges</u>			
	<u>1965</u>		<u>1966</u>	
	<u>Strikes</u>	<u>Bridges</u>	<u>Strikes</u>	<u>Bridges</u>
Rail and rail/highway	67	14	110	16
Highway	77	30	76	23
Total	<u>144</u>	<u>44</u>	<u>186</u>	<u>39</u>

b. Armed Reconnaissance Bridge Targets

The destruction or damage of nearly 390 bridges, including those on the JCS target list, has been confirmed by aerial photography. One hundred and eighty of these were struck initially during 1966.

Pilots have reported destroying or damaging about 1,920 bridges during 1966, for a total of 2,580 bridges throughout the bombing. This total undoubtedly contains considerable double-counting and overstatement of the damage inflicted. A total of 389 bridges is confirmed by photography to be destroyed or damaged. This figure understates the number of smaller bridges damaged or destroyed because photography may not be available for some of the bridges. A comparison of the two sets of data follows:

	<u>Bridges Destroyed or Damaged</u>	
	<u>Photographic Evidence</u>	<u>Pilot Reports</u>
Railroad and combination	96	99
Highway	293	2,480
Total	<u>389</u>	<u>2,579</u>

5. Railroad Yards

Seven comparatively important railroad yards have been struck during the Rolling Thunder program, four of which are JCS targets. In addition, many small yards and sidings have been attacked by armed reconnaissance. Three significant yards -- at Thai Nguyen, Yen Vien, and Gia Lam -- were attacked for the first time in 1966. The cost of restoration of the damage inflicted on rail yards during 1966 is estimated at about \$1.2 million, compared with only \$70,000 for that in 1965. Most of these values stem from the cost of repairing or reconstructing warehouses and other buildings rather than yard track. Airstrikes on these yards have resulted in only temporary disruption to through rail service on the rail lines, which usually has been restored within about 24 hours after each attack.

6. Maritime Ports

Six North Vietnamese ports representing 88 percent of the country's total maritime cargo-handling capacity have been selected as JCS targets. Only three of these ports -- Ben Thuy, Ham Rong, and Cam Pha -- have been attacked. Damage to port facilities amounts to \$1.4 million, of which about \$750,000 resulted from strikes in 1966.

The impact of this damage on North Vietnam's economy is not significant, but major export losses have resulted. Although Cam Pha is a major North Vietnamese port, representing 16 percent of the country's maritime cargo capacity, the \$160,000 damage against it is nominal. During the attacks on Cam Pha, however, the coal-washing machinery and rail facilities at the port were also hit. The damage to these facilities resulted in a loss of coal exports amounting to \$4.7 million in 1966.

Port facilities at Haiphong, which represent nearly 50 percent of the country's maritime port capacity, have not been attacked. However, the petroleum terminal was damaged during the airstrikes against petroleum bulk storage facilities in the summer of 1966. This has affected petroleum imports, since tankers must now discharge into petroleum barges from a sheltered deep-water anchorage in Ha Long Bay.

7. Locks

Only two of the eight targeted locks on the inland waterways in North Vietnam have been attacked. The first strike, in August 1965, was against the Bich Phuong Lock No. 3 on the Song Chu Canal in Thanh Hoa Province and resulted in heavy damage to the lock. By October 1965, however, temporary repairs had been made and the site of the lock had been cofferdammed. Water-level control has been restored, and navigation on the canal is possible, although it is interrupted at the site of the lock. During 1966 a strike against the Qua Nhue Ha Lock No. 2, on the same canal, was unsuccessful.

8. Agriculture and Fishing

Although agriculture and commercial fishing have not been direct targets of the airstrikes against North Vietnam, these attacks have had significant indirect effects on production during the past two years. It has not been possible, however, to separate the

effects of the bombing from the effects of adverse weather on agriculture, and so the estimates of losses in agricultural output also include those resulting from adverse weather.

The decrease from normal agricultural production and losses in the fish catch during 1965-66 are valued at an estimated \$30.5 million, \$25.3 million of which occurred during 1966. Of the total amount, \$25.5 million is attributed to a shortfall in rice production and the remainder, \$5 million, is attributed to a decrease in the salt-water fish catch.

The shortfall in rice production and the decrease in the salt-water fish catch have contributed to food shortages in North Vietnam. Rice normally accounts for about two-thirds of the caloric intake of the population, and fish is the main source of protein. There is some evidence that these food shortages have become somewhat worse in the past few months -- particularly in Hanoi. There are no indications of critical food shortages thus far, however, and identified bulk food imports in 1966 were lower than those in 1965.

9. Export Losses

From 1 April 1965 to 31 December 1966, measurable export losses attributed to direct and secondary effects of the Rolling Thunder program totaled \$15.8 million, of which \$4.2 million occurred in 1965 and \$11.6 million in 1966. Reduction in exports of apatite and coal accounted, respectively, for 60 percent and 30 percent of the total. The remainder of the losses is accounted for by an apparent reduction* in seaborne exports of cement since the initiation of the Rolling Thunder program.

C. Military Targets

1. Barracks

Although about 50 airstrikes were made against at least 19 JCS-targeted barracks during 1966, these strikes did not significantly increase the damage to barracks inflicted during 1965. All but two of the barracks had been struck in 1965, and more than half of them

* It is possible that undetected increases in exports of cement to China have been made on Chinese Communist ships.

appeared to have been inactive at the end of 1965. The attacks during 1966 increased the percent of barracks capacity destroyed or inactive to about 23 percent of the total national capacity, compared with a little more than 18 percent destroyed or inactive at the end of 1965. The cost of restoration of the damage inflicted in 1966 is estimated at about \$1.9 million, compared with about \$16 million in 1965.

It is believed that the total capacity destroyed to date represents for the most part only excess or unused capacity. Most of the important barracks are located in the Hanoi-Haiphong area and have not been attacked. The military strength in this area far exceeds that in the outlying areas which have been struck, and sufficient capacity remains to house all of North Vietnam's military forces.

The lack of barracks capacity in the areas where destruction has taken place -- in the southern part of the country along the border of Laos, and in the northwestern provinces -- is undoubtedly causing much inconvenience. Damage to barracks in these areas has not been repaired, and the troops apparently are being quartered with civilians in nearby towns, in tents, and in other makeshift shelters in surrounding areas.

2. Airfields

Almost no change has occurred in North Vietnam's airfield capability as a result of US air attacks during 1966. Of the 23 airfields in North Vietnam, 11 are targeted and are considered to be of economic and military significance. Four of the targeted airfields have been struck, resulting in the destruction of about 20 percent of the total targeted airfield capacity. Two of these -- Dien Bien Phu and Dong Hoi -- were restructed in 1966. The damage inflicted on airfields has had only limited military and economic effects.

3. SAM Sites

In 1966, 115 airstrikes were carried out against 61 surface-to-air (SAM) sites. The North Vietnamese are believed to be limited to about 25 SAM firing units (battalions), most of which have exhibited a high degree of mobility. Therefore, although 151 SAM sites had been identified as of 31 December, not more than 20 to 25 of them are believed to have been occupied at any one time.

The sparseness of poststrike photography prevents making a precise assessment of the amount of damage actually sustained by these SAM facilities; that reported by pilots could have totaled at least \$17 million*; however, only destruction of equipment valued at some \$900,000 was verified by photography. The actual amount of damage to SAM firing sites probably is closer to \$6 million. In addition, three attacks on the Haiphong SAM Support Facility inflicted an estimated \$70,000 damage to buildings and a probable minimum of \$100,000 damage to equipment. Damage to SAM facilities in 1965 was estimated at about \$630,000.

During this period, at least 1,100 missiles (valued at about \$33 million**) were fired against allied targets, resulting in the confirmed destruction of 29 planes and 14 drones.

4. Naval Bases

By the end of 1966, airstrikes against naval bases had destroyed nearly 20 percent of North Vietnam's naval support facilities. The damage is estimated at \$1.2 million during 1965 and about \$400,000 during 1966.

During 1966 an initial strike on the Bai Chay Naval Complex, located in the Hon Gai port area, resulted in the destruction of only about 14 percent of its capability. However, possibly as a consequence of this strike, some of the command responsibilities for naval operations in the Hon Gai area have been shifted from Bai Chay to the newly constructed command post at Binh Dong in the Haiphong area. The damage to the bases has not seriously affected operations of the small North Vietnamese navy.

5. Radar

North Vietnam has 50 known radar sites, of which five coastal sites were targeted because of their strategic location. During 1965-66 these five targeted sites were attacked. Damage or destruction

* Assuming that all of the sites reported destroyed were occupied when struck and most of the major equipment was destroyed: specifically, the Fan Song radar, cabling, and an average of five launchers and three missiles. No attempt has been made to assign a value to the "damaged" category.

** This cost is not included in the estimated costs of physical damage resulting from the Rolling Thunder program.

of targeted sites amounted to an estimated \$1.7 million during 1965 and to slightly over \$900,000 in 1966, for a total of \$2.6 million.

6. Communications

The Rolling Thunder program has not seriously impaired the operational effectiveness of telecommunications in North Vietnam. By the end of 1966 the total monetary cost of damage inflicted by air attacks on North Vietnamese telecommunications amounted to about \$185,000, of which about \$105,000 occurred during 1965 and \$80,000 in 1966.

The full extent of physical damage to the wireline system of North Vietnam cannot be estimated. The wireline system has not been specifically targeted for destruction, and the damage sustained has been a collateral effect of the bombing of railroads and highways, which are generally paralleled by open wirelines. There is a strong possibility -- suggested in part by the construction of seven new open wireline routes -- that wireline damage has been extensive, but there is no conclusive evidence of this. Cumulative monetary damage to the open wireline system since the beginning of Rolling Thunder is estimated very roughly at \$100,000, of which \$80,000 probably occurred during 1966.

Although the total cost of damage inflicted on telecommunications facilities in North Vietnam is small, indirect costs in this field resulting from a need for increased domestic communications appear to be substantial. Although it is impossible to distinguish precisely between communications requirements induced as a direct result of bomb damage and those generated by the expansion of North Vietnam's military establishment, it is clear that the Rolling Thunder program has been an important, if not the prime, reason for increasing the complexity of North Vietnam's communications problems.

7. Supply and Ordnance Depots

Twelve of the 17 targeted supply depots have been attacked under the Rolling Thunder program. The only significant strikes during 1966 were against the Van Dien Vehicle Depot Complex, located a short distance south of Hanoi. This complex constitutes a significant portion of North Vietnam's military motor vehicle repair capacity. The cost of restoration of the damage inflicted by the three strikes against the complex in December is estimated at \$500,000. Restrikes on a few

other depots bring the total to about \$630,000 for damage inflicted in 1966 compared with a cost of at least \$3 million for damage inflicted during 1965. Destruction of supply and ordnance depots through 1966 represents less than 15 percent of the national capacity.

8. Ammunition Depots

Available information indicates that airstrikes were carried out against only two of the 18 JCS-targeted ammunition depots during 1966 -- the Xom Bang and the Xom Rung depots, both of which had been attacked in 1965 and were inactive at the end of the year. The attacks in 1966 resulted in only slight additional damage, estimated at about \$200,000. Attacks during 1965 against 13 depots resulted in damage amounting to about \$4.5 million. It is estimated that airstrikes through 1966 destroyed about one-fourth of the national storage capacity for ammunition, exclusive of storage in barracks and headquarters complexes. The destruction of the depots probably has caused temporary delays in distribution and inconvenience but has not caused shortages of ammunition in the areas where they are located.

9. Naval Craft

A total of 10 North Vietnamese naval craft were destroyed by US aircraft through 1966. In 1965, three Swatow-class gunboats were sunk while in waters near Haiphong and Hon Gai, and a fourth was destroyed while in tow at sea. In 1966, three PT boats were sunk while at sea, and two SO-1 subchasers and one Swatow-class gunboat were destroyed while moored near Cac Ba Island. The estimated restoration cost of these naval craft totals \$8.1 million. The loss incurred during 1966 accounts for \$6.1 million.

10. Aircraft

North Vietnamese aircraft losses increased measurably during 1966. Six supersonic MIG-21's and 16 MIG-17's were destroyed, compared with only five MIG-17's in 1965. The estimated cost of these losses is \$3.4 million in 1965 and \$17 million in 1966.

D. Armed Reconnaissance

During 1966, Rolling Thunder became almost exclusively an armed reconnaissance program directed primarily against the North Vietnamese lines of communication and transport targets. The effect of airstrikes against lines of communication and other fixed targets is discussed in an earlier section of this appendix.

1. Transport Equipment

Destruction and damage of all types of transport equipment by airstrikes was considerably greater in 1966 than in 1965. The following tabulation, which is based primarily on pilot reports and includes some duplication and exaggeration, * provides a general indication of the increase in the damage inflicted, by type of equipment.

<u>Type of Equipment</u>	<u>1965</u>		<u>1966</u>	
	<u>Destroyed</u>	<u>Damaged</u>	<u>Destroyed</u>	<u>Damaged</u>
Locomotives	6	6	10	14
Rail freight cars	227	592	1,101	935
Trucks	318	487	1,935	1,801
Ferries	53	56	67	131
Barges	263	487	2,520	4,289
Other water craft	144	210	867	1,372
Total	<u>1,011</u>	<u>1,838</u>	<u>6,500</u>	<u>8,542</u>

The estimated cost to the North Vietnamese of replacing destroyed and repairing damaged transport equipment increased from \$5.9 million in 1965 to \$29.8 million in 1966, giving a total of \$35.7 million.

In spite of the significantly higher level of damage inflicted during 1966, there has been no evidence of serious transport problems resulting from shortages of equipment. Imports of locomotives and trucks have been sufficient generally to maintain inventories at the 1965 level. Reported losses of freight cars have included many small, make-shift cars used on the rail lines south of Hanoi which are not included in the inventory of mainline freight cars. Although the original inventory of mainline freight cars decreased by possibly 35 percent during 1966, Communist China probably has loaned or given North Vietnam all the freight cars needed to compensate for any shortages. Sightings of watercraft indicate that there has been no significant decrease in the number of watercraft in use during 1966 in spite of the high level of destruction.

* Data have been adjusted downward to eliminate duplication whenever possible.

2. Miscellaneous Targets of Armed Reconnaissance

Pilot and bomb-damage assessment reports have revealed a variety of miscellaneous targets which have been destroyed or damaged by armed reconnaissance. These miscellaneous targets consist mainly of transport and military facilities.

The cost of restoring or repairing the miscellaneous transport facilities attacked in 1966 is roughly estimated at about \$1.2 million and the military facilities at about \$2.3 million. Damage to all such miscellaneous military targets in 1965 was estimated at about \$700,000.

II. Rolling Thunder Operations in 1966

A. Scale of Operations

During 1966, US and South Vietnamese forces flew approximately 147,850 sorties against targets in North Vietnam, nearly 2.7 times the number flown in 1965 (see Table A1*). Rolling Thunder accounted for about 35 percent of the total sorties flown in Southeast Asia in 1966, compared with 30 percent the year before. Similarly, the share of Laos increased from 9 percent of all sorties flown in Southeast Asia in 1965 to 18 percent in 1966, while the share of South Vietnam dropped from 61 percent in 1965 to 47 percent in 1966, as is shown by the following tabulation:

<u>Area of Operation</u>	<u>1965</u>		<u>1966</u>	
	<u>Number of Sorties</u>	<u>Percent of Total</u>	<u>Number of Sorties</u>	<u>Percent of Total</u>
North Vietnam	55,210	30	147,850	35
Laos	16,030	9	76,110	18
North Vietnam and Laos combined	<u>71,240</u>	<u>39</u>	<u>223,960</u>	<u>53</u>
South Vietnam	<u>110,310</u>	<u>61</u>	<u>204,120</u>	<u>47</u>
Total Southeast Asia	<u>181,550</u>	<u>100</u>	<u>428,080</u>	<u>100</u>

* Tables A1 through A6 (pages A-22 through A-27) summarize the principal measures of the Rolling Thunder program. In addition to these, a number of tables on air operations in South Vietnam and Laos and tables summarizing the operations against specific target systems have been prepared but are not published in this appendix. These tables are available in the Office of Research and Reports. A listing of the unpublished tables is presented on p. A-28.

Approximately 82,170 attack sorties were flown against North Vietnam in 1966, which represents about 56 percent of all Rolling Thunder sorties during the year. This compares quite favorably with 1965, when only 47 percent of all Rolling Thunder sorties against North Vietnam were attack sorties, and is in contrast with a decline in the share of total sorties represented by attack sorties against South Vietnam and Laos in 1966. The percentages of attack and support sorties in each area are shown in the following tabulation:

Year	Percent							
	North Vietnam		Laos		South Vietnam		All Areas of Operation in Southeast Asia	
	Attack Sorties	Support Sorties	Attack Sorties	Support Sorties	Attack Sorties	Support Sorties	Attack Sorties	Support Sorties
1965	47	53	68	32	85 <u>a/</u>	15 <u>a/</u>	70 <u>a/</u>	30 <u>a/</u>
1966					76 <u>a/</u>	24 <u>a/</u>		
1966 <u>b/</u>	56	44	64	36	79	21	68	32

a. US sorties only. Distribution of sorties by the South Vietnamese Air Force over South Vietnam in 1965 is not available.

b. All US and South Vietnamese sorties.

The air campaign against North Vietnam was overwhelmingly a US effort. * The South Vietnamese Air Force accounted for only about 1 percent of the total sorties flown over North Vietnam in both 1965 and 1966. Further details concerning the percentage of total sorties flown against North Vietnam by various services are presented in the following tabulation:

	Percent	
	1965	1966
US Air Force	44	53
US Navy	53	42
US Marine Corps	2	4
Total US	99	99
Vietnamese Air Force	1	1
Total	100	100

* For a summary of sorties against North Vietnam, by mission and nationality, see Table A1.

During the first 9 months of 1966, approximately 44 percent of the total sorties flown against North Vietnam originated from Navy aircraft carriers, 36 percent from US Air Force bases in Thailand, and 20 percent from bases in South Vietnam.

Since mid-1965 the increase in sorties flown over North Vietnam and Laos combined has been roughly parallel to the increase in sorties flown over South Vietnam. However, when the number of sorties flown against North Vietnam is increasing, a smaller number of sorties usually is flown against Laos, and vice versa. During the first 8 months of 1966 the increase in sorties flown over North Vietnam was roughly proportional to the decrease in sorties flown over Laos. Conversely, during the last quarter of the year a decline in the number of sorties flown over North Vietnam was accompanied by a substantial increase in sorties flown over Laos.

The 1966 Rolling Thunder program varied radically from the 1965 campaign in the increasing emphasis on armed reconnaissance rather than on attacking fixed targets. In 1966, only 2,620 sorties were flown against JCS-designated fixed targets, compared with 13,890 sorties in 1965. (See Table A2.) Armed reconnaissance (excluding restrikes on JCS fixed targets) accounted for 98 percent of all sorties flown against North Vietnam in 1966, compared with only 75 percent in 1965.

The increasing emphasis on Rolling Thunder as an interdiction program is evident from the geographic distribution of the air effort. During the first 11 months of 1966, approximately 63 percent of the total attack sorties over North Vietnam were concentrated in the three southernmost armed reconnaissance Route Package areas, Routes 1, 2, and 3.* (See Table A3.) These three Route Package areas cover the North Vietnamese Panhandle area south from Thanh Hoa to the Demilitarized Zone. On the other hand, only 7 percent of the sorties were flown over Route Package 6, the key northeast area which contains most of the lucrative fixed targets and the two most important rail lines in North Vietnam.

B. Ordnance

During 1966, sorties flown over North Vietnam delivered a total of 128,070 tons of ordnance. (See Table A4.) This amounted to 27 percent of the total ordnance delivered by all air operations in Southeast Asia. The amount of ordnance delivered on targets in North Vietnam and Laos

* North Vietnam is divided, for operations, into six geographic areas, known as Route Packages. (See Figure 5.)

combined accounted for a little less than half of the total ordnance delivered by air operations in Southeast Asia. Throughout the first 9 months of the year, increases in the amount delivered on North Vietnam approximately offset the decline in the amount delivered on Laos. During the last quarter of the year, however, the pattern reversed itself, with deliveries on North Vietnam falling below the levels achieved during the third quarter, while deliveries on Laos increased substantially.

The average ordnance load per attack sortie against North Vietnam during 1966 was 1.6 tons per sortie (see the following tabulation), a slight increase over the 1.3 tons per sortie averaged in 1965.

Area of Operation	Ordinance in 1966				
	Attack Sorties in 1966		Average Load Per Sortie		
	Number	Percent	Tons	Percent	Tons
North Vietnam	82,170	28	128,070	27	1.6
Laos	48,480	17	74,120	15	1.5
North Vietnam and Laos com- bined	<u>130,650</u>	<u>45</u>	<u>202,190</u>	<u>42</u>	1.5
South Vietnam	<u>161,350</u>	<u>55</u>	<u>278,050</u>	<u>58</u>	1.7
Total Southeast Asia	<u>292,000</u>	<u>100</u>	<u>480,240</u>	<u>100</u>	1.6

The US Air Force delivered 59 percent of all ordnance expended on North Vietnam during 1966, the US Navy 35 percent, the US Marine Corps 5 percent, and the South Vietnamese Air Force 1 percent. The shares in total ordnance delivered on North Vietnam in 1966 are compared with those for 1965 in the following tabulation:

	Percent			
	US Air Force	US Navy	US Marine Corps	South Vietnamese Air Force
1965	62	35	N.A.	3
1966	59	35	5	1

Ordnance delivered on JCS-designated fixed targets in North Vietnam during 1966 was only 3 percent of the total, compared with 37 percent in 1965. This sharp decrease reflects the rapidly diminishing share of fixed targets in the total attack on North Vietnam. A summary of the attack sorties and ordnance delivered on JCS fixed targets in North Vietnam during 1965 and 1966 is presented in Table A5.

C. Losses

A total of 318 aircraft and 269 men were lost in the air attacks on North Vietnam during 1966. An additional 177 men were lost but later recovered. The recovery rate in 1966 -- 40 percent -- was an improvement over the rate in 1965, when 30 percent were recovered. The improvement is particularly notable in view of the fact that many of the losses occurred during attacks on targets located in heavily defended areas.

In both 1965 and 1966 the service that flew the largest number of sorties lost the largest number of planes. In 1965 this was the US Navy and in 1966, the US Air Force. Losses, by service, are compared for 1966 and 1965 in Table A6.

Losses as a percent of total sorties flown by models of aircraft most used remained about the same in 1966 as in 1965 or were slightly lower. For the most part, losses of frequently used models were in the range of 0.3 to 0.5 percent.

The average number of aircraft lost per 1,000 attack sorties dropped from about 6.6 in 1965 to a little less than 3.9 in 1966. The average number of combat losses in 1966 was only 3.4 aircraft per 1,000 attack sorties. See the following tabulation:

<u>Year</u>	<u>Total Attack Sorties</u>	<u>Total Losses</u>	<u>Losses as a Percent of Total Attack Sorties</u>
1965	25,940	171	0.66
1966	82,170	318 <u>a/</u>	0.39 <u>a/</u>

a. Of the 318 aircraft lost in 1966, 282 were combat losses and 36 were operational losses. Combat losses represent 0.34 percent of total attack sorties.

In 1966, as in 1965, the rate of loss over North Vietnam was much higher for attacks on JCS fixed targets than for armed reconnaissance. The average number of aircraft lost per 1,000 attack sorties flown against JCS fixed targets was 10 in 1966, somewhat more than the rate of about 8.5 in 1965, as shown in the following tabulation.

<u>Year</u>	<u>Attack Sorties Flown</u>		<u>Aircraft Lost During</u>		<u>Losses as a Percent of Attack Sorties on</u>	
	<u>Against JCS Fixed Targets</u>	<u>On Armed Reconnaissance, Photo Reconnaissance, and Other</u>	<u>Attacks On JCS Fixed Targets</u>	<u>Armed Reconnaissance, Photo Reconnaissance, and Other</u>	<u>JCS Fixed Targets</u>	<u>Armed Reconnaissance, Photo Reconnaissance, and Other</u>
1965	8,710	17,230	74	97	0.85	0.56
1966	2,100	80,070	21	297	1.00	0.37

The higher loss ratio for attacks on JCS fixed targets undoubtedly reflects the more intensive defense around such targets.

Losses per 1,000 attack sorties flown over North Vietnam in 1966 were higher than for other areas of operation in Southeast Asia. The comparable figures were as follows:

<u>Area of Operation</u>	<u>Aircraft Lost per 1,000 Attack Sorties Flown in 1966</u>
North Vietnam	3.9
South Vietnam	1.6
Laos	1.5
All areas of operation in Southeast Asia	2.2

D. Costs of Operations Against North Vietnam in 1966

The direct operational cost of the air attack on North Vietnam during 1966 is estimated at about \$1,250 million, or more than 2.7 times the cost of the attack during 1965. This figure includes

the production cost of the aircraft lost, valued at \$606 million; direct sortie overhead costs, estimated at approximately \$330 million (not including any allowance for maintenance of air bases and the aircraft carriers or for logistic support); and ordnance costs of about \$312 million. These costs are compared with similar ones for 1965 in the following tabulation:

	<u>Million US \$</u>		
	<u>1965</u>	<u>1966</u>	<u>Total 1965-66</u>
Aircraft lost	305.8	605.6	911.4
Sortie overhead cost	98.0	330.4	428.4
Ordnance	56.2	311.5	367.7
Total	<u>460.0</u>	<u>1,247.5</u>	<u>1,707.5</u>

The cost of air operations over North Vietnam was almost half of the total operating cost of more than \$2.7 billion for all air operations in Southeast Asia during 1966.

The measurable costs to North Vietnam for the reconstruction or repair of bomb-damaged facilities and other indirect losses attributable to the bombing during 1966 have been estimated at about \$130 million. Thus the cost of inflicting one dollar's worth of damage on North Vietnam during 1966 may be estimated at about \$9.60. The comparable figure in 1965 was approximately \$6.60. The cost of inflicting damage on North Vietnam averaged, therefore, about 45 percent more in 1966 than in 1965. The increase in cost per unit of damage is attributable primarily to the increasing costs of a greatly accelerated air interdiction program concentrated on low-yield target systems. The disparity between the unit cost to the United States of doing damage in North Vietnam and the cost to North Vietnam of replacing or repairing the damaged facilities makes it evident that the value of attacking targets in North Vietnam must be measured in military, political, and psychological terms rather than economic terms.

E. The Attack on Fixed Target Systems

The attack on JCS-designated fixed targets has represented a much smaller effort in 1966 than in 1965. Only 2,620 sorties were flown against such targets in 1966, compared with 13,890 sorties in 1965, and only 3,560 tons of ordnance were delivered, compared with

12,800 tons, during a shorter time period, last year. (See Table A5.) As of 31 December 1966, there were 242 targets on the JCS list. A total of 158 targets from the list were struck in 1965, including 23 no longer carried on the current list. During 1966, 73 of the targets that were struck last year were restruck, and 27 new targets were struck for the first time. At the end of 1966 there remained on the list 81 targets that had not been struck.

Table A1

Sorties Against North Vietnam, by Mission and Nationality a/
1965 and 1966

Year and Month	By US Services			By the South Vietnamese Air Force			Total		
	Attack Sorties <u>b/</u>	Support Sorties	Total Sorties	Attack Sorties <u>b/</u>	Support Sorties	Total Sorties	Attack Sorties <u>b/</u>	Support Sorties	Total Sorties
1965									
January	0	0	0	0	0	0	0	0	0
February	130	70	200	60	0	60	190	70	260
March	530	240	770	120	Negl.	120	650	240	890
April	1,500	1,360	2,860	100	10	110	1,600	1,370	2,970
May	1,510	2,710	4,220	100	20	120	1,610	2,730	4,340
June	2,310	1,530	3,840	90	10	100	2,400	1,540	3,940
July	3,160	2,960	6,120	70	10	80	3,230	2,970	6,200
August	3,420	3,790	7,210	30	10	40	3,450	3,800	7,250
September	3,990	1,230	5,220	20	Negl.	20	4,010	4,230	8,240
October	3,460	4,550	8,010	10	Negl.	10	3,470	4,550	8,020
November	3,120	4,180	7,300	10	Negl.	10	3,130	4,180	7,310
December	2,170	3,570	5,740	30	20	50	2,200	3,590	5,790
Total 1965	<u>25,300</u>	<u>29,190</u>	<u>54,490</u>	<u>640</u>	<u>80</u>	<u>720</u>	<u>25,940</u>	<u>29,270</u>	<u>55,210</u>
1966									
January	130	2,890	3,020	0	0	0	130	2,890	3,020
February	2,810	3,710	6,520	0	0	0	2,810	3,710	6,520
March	4,480	4,940	9,420	10	10	20	4,490	4,950	9,440
April	5,310	5,090	10,400	140	0	140	5,450	5,090	10,540
May	4,360	4,250	8,610	110	0	110	4,470	4,250	8,720
June	7,520	5,430	12,950	270	0	270	7,790	5,430	13,220
July	9,960	6,240	16,200	240	0	240	10,200	6,240	16,440
August	11,790	7,030	18,820	20	0	20	11,810	7,030	18,840
September	12,340	6,880	19,220	10	0	10	12,350	6,880	19,230
October	8,700	6,060	14,760	Negl.	0	Negl.	8,700	6,060	14,760
November	7,250	6,180	13,430	10	0	10	7,260	6,180	13,440
December	6,710	6,970	13,680	Negl.	0	Negl.	6,710	6,970	13,680
Total 1966	<u>81,360</u>	<u>65,670</u>	<u>147,030</u>	<u>810</u>	<u>10</u>	<u>820</u>	<u>82,170</u>	<u>65,680</u>	<u>147,850</u>
Total 1965-66	<u>106,660</u>	<u>94,860</u>	<u>201,520</u>	<u>1,450</u>	<u>90</u>	<u>1,540</u>	<u>108,110</u>	<u>94,950</u>	<u>203,060</u>

a. Rounded to the nearest 10 sorties. Negl. includes fewer than 5 sorties.
b. Attack sorties include strike and flak suppression sorties.

Table A2

Sorties Against North Vietnam, by Program and by Service
1965 and 1966

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	On Fixed Targets		On Armed Reconnaissance		Total on Armed Reconnaissance		Services			
Year and Month	Total on Fixed Targets (Columns 2 and 3)	By Fixed Target Strikes	By Armed Reconnaissance Strikes	Armed Reconnaissance Not on Fixed Targets	Total on Armed Reconnaissance (Columns 3 and 4)	Total (Columns 1 and 4)	United States			South Vietnamese
							Air Force	Navy	Marine	Air Force
1965										
January	0	0	0	0	0	0	0	0	0	0
February	0	0	0	260	260	260	80	120	N.A.	60
March	850	850	0	40	40	890	360	410	N.A.	120
April	1,800	1,460	340	1,170	1,510	2,970	1,200	1,660	N.A.	110
May	1,790	1,300	490	2,550	3,040	4,340	2,280	1,940	N.A.	120
June	1,410	1,360	50	2,530	2,580	3,940	1,840	2,000	N.A.	100
July	1,910	1,590	320	4,290	4,610	6,200	2,380	3,600	140	80
August	1,900	1,390	510	5,350	5,860	7,250	3,030	4,030	150	40
September	1,600	1,440	160	6,640	6,800	8,240	3,890	4,160	170	20
October	770	570	200	7,250	7,450	8,020	3,480	4,370	160	10
November	1,040	570	470	6,270	6,740	7,310	3,330	3,830	140	10
December	820	530	290	4,970	5,260	5,790	2,630	2,980	130	50
Total	13,890	11,060	2,830	41,320 a/	44,150 a/	55,210 a/	24,500	29,100	890	720
1966										
January	0	0	0	3,020	3,020	3,020	1,570	1,220	230	0
February	170	0	170	6,350	6,520	6,520	3,190	3,160	170	0
March	180	0	180	9,260	9,440	9,440	4,600	1,630	190	20
April	390	50	340	10,150	10,490	10,540	4,850	5,410	110	140
May	160	0	160	8,560	8,720	8,720	4,060	4,420	130	110
June	320	240	80	12,900	12,980	13,220	7,340	5,420	190	270
July	360	50	310	16,080	16,390	16,440	9,520	6,100	580	240
August	280	20	260	18,560	18,820	18,840	9,660	8,120	1,040	20
September	150	0	150	19,080	19,230	19,230	10,110	8,090	1,020	10
October	150	0	150	14,610	14,760	14,760	8,410	5,670	680	Neg1.
November	110	30	110	13,300	13,410	13,440	7,130	5,490	810	10
December	320	30	290	13,560	13,650	13,680	8,150	4,820	710	Neg1.
Total	2,620	120	2,200	145,230	147,130	147,850	78,590	62,550	5,890	820

a. Also including 645 miscellaneous sorties such as leaflet drops, gift drops, and photo reconnaissance sorties not accompanying a strike mission.

Table A3

Distribution of Sorties over North Vietnam, by Route Package a/
1966

							Percent	
	Route Package							
Month	1	2	3	4	5	6	Unknown	Total
January	17	18	30	4	3	0	28	25X1
February	31	24	15	3	5	10	22	100
March	34	31	13	5	11	10	6	100
April	37	29	17	3	6	3	5	100
May	30	19	26	10	6	4	5	100
June	49	19	14	8	1	4	5	100
July	47	18	12	5	4	8	6	100
August	35	16	11	9	1	12	16	100
September	39	16	12	17	5	8	3	100
October	45	8	15	13	5	7	7	100
November	43	12	16	13	6	7	3	100
December	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Eleven-month average	34	15	14	9	4	7	17	100

a. North Vietnam is divided, for operations, into six geographic areas, known as Route Packages. Percentage data shown are approximate, because of the effects of multiple-route-package sorties and coastal sorties.

Table A4

Ordinance Delivered by Air on North Vietnam, by Month and by Program
March-December 1965 and January-December 1966

							Tons
	(1)	(2)	(3)	(4)	(5)	(6)	
	On JCS Fixed Targets			On Armed Reconnaissance			
	Total on JCS Fixed Targets (Columns 2 and 3)	By Fixed Target Strikes	By Armed Reconnaissance Strikes	Armed Reconnaissance Not on Fixed Targets	25X1 Total on Armed Reconnaissance (Columns 3 and 4)	Total (Columns 1 and 4)	
Year and Month							
1965							
March	1,130	1,130	0	0	0	1,130	
April	1,830	1,620	210	430	640	2,260	
May	1,420	1,420	0	380	380	1,800	
June	1,900	1,900	0	1,430	1,430	3,330	
July	1,490	1,410	80	1,980	2,060	3,470	
August	1,470	1,280	190	3,200	3,390	4,670	
September	1,790	1,780	10	3,730	3,740	5,520	
October	700	590	110	4,390	4,500	5,090	
November	620	480	140	3,900	4,040	4,520	
December	450	350	100	2,060	2,160	2,510	
Total	12,800	11,960	840	21,500	22,340	34,300	
1966							
January	0	0	0	270	270	270	
February	270	0	270	4,510	4,780	4,780	
March	220	0	220	7,520	7,740	7,740	
April	460	80	380	8,580	8,960	9,040	
May	220	0	220	7,330	7,550	7,550	
June	280	190	90	10,680	10,770	10,960	
July	440	60	380	15,900	16,280	16,340	
August	460	40	420	16,870	17,290	17,330	
September	260	0	260	17,500	17,760	17,760	
October	220	0	220	13,500	13,720	13,720	
November	240	10	230	10,930	11,160	11,170	
December	490	60	430	10,920	11,350	11,410	
Total	3,560	440	3,120	124,510	127,630	128,070	

Table A5

Attacks on JCS Fixed Targets in North Vietnam
1965 and 1966

Year and Program	Sorties Flown				Ordnance Delivered	
	Strike and Flak Suppression	Support	Total		Tons	P25X1nt
			Number	Percent		
1965						
Fixed target	6,930	4,130	11,060	80	11,960	93
Armed reconnaissance	1,780	1,050	2,830	20	840	7
Total March- December 1965 a/	<u>8,710</u>	<u>5,180</u>	<u>13,890</u>	<u>100</u>	<u>12,800</u>	<u>100</u>
1966						
Fixed target	270	150	420	16	440	12
Armed reconnaissance	1,830	370	2,200	84	3,120	88
Total January- December 1966	<u>2,100</u>	<u>520</u>	<u>2,620</u>	<u>100</u>	<u>3,560</u>	<u>100</u>

a. There were no attacks on JCS fixed targets until March 1965.

25X1

A-26

Table A6

Aircraft and Personnel Losses in Attacks
on North Vietnam, by Service
1965 and 1966

	Service	Aircraft	Personnel	
			Lost	Recovered
				25X1
1965				
	US Air Force	77	62	30
	US Navy	86	76	30
	US Marine Corps	0	0	0
	South Vietnamese Air Force	8	6	2
Total		<u>171</u>	<u>144</u>	<u>62</u>
1966				
	US Air Force	174	165	85
	US Navy	139	96	86
	US Marine Corps	4	8	2
	South Vietnamese Air Force	0	0	0
	US Army	1	0	4
Total		<u>318 a/</u>	<u>269</u>	<u>177</u>

a. 282 combat losses and 36 operational losses.

Unpublished Tables

Petroleum Storage Facilities Attacked Under the Rolling Thunder Program, 1965 and 1966

Electric Power Facilities Attacked Under the Rolling Thunder Program, 1965 and 1966

Manufacturing Facilities Attacked Under the Rolling Thunder Program, 1965-66

Railroad Yards Attacked Under the Rolling Thunder Program, 1965-66

Maritime Ports Attacked Under the Rolling Thunder Program, 1965 and 1966

Barracks Attacked Under the Rolling Thunder Program, 1966

Airfields Attacked Under the Rolling Thunder Program, 1965 and 1966

Naval Bases Attacked Under the Rolling Thunder Program, 1965 and 1966

Inventory of Miscellaneous Damage, by Armed Reconnaissance Sorties, 1965-66

Sorties and Delivered Ordnance in Southeast Asia, by Service, 1965 and 1966

Sorties over South Vietnam, by Mission and Nationality, 1965 and 1966

United States Sorties over Laos, by Mission, 1965 and 1966

Sorties over All Areas of Operation in Southeast Asia, by Mission and Nationality, 1965 and 1966

Ordnance Delivered on North Vietnam, by Month and by Service, March 1965 - December 1966

Ordnance Delivered by Air in Southeast Asia, by Month, March-September 1965 and January-December 1966

Losses by Model of Aircraft in Operations Against North Vietnam, 1965 and 1966

Aircraft Losses in Southeast Asia, by Area of Operation, Nationality, and Type of Loss, January-December 1966

Direct Operational Costs Related to Costs of Damage to the Economy of North Vietnam, January 1965 - December 1966

Cost of Air Operations in Southeast Asia, January-December 1966

Comparison of Strikes on Major JCS Fixed Target Systems in North Vietnam, 1965 and 1966

Comparison of Sorties and Ordnance on Major JCS Fixed Target Systems in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Airfields in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Bridges in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Railroad Yards and Shops in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Barracks, Supply Depots, Ammunition Depots, and Military Complexes in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Petroleum Storage in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Ports and Naval Bases in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Radar Sites in North Vietnam, 1965 and 1966

Statistical Summary of Attacks on Electric Power Facilities in North Vietnam, 1965 and 1966

APPENDIX B

MODERN INDUSTRY IN NORTH VIETNAM
AS A TARGET SYSTEM

1. A review of modern industry in North Vietnam has resulted in the selection of 20 facilities for inclusion in this target system*:

Seven electric power generating plants

One cement plant

One explosives plant and one potential
supplier of explosives materials

One rubber products facility

One chemical plant

Four engineering plants

One steel-producing complex

Three coal-processing plants

2. The neutralization of all these North Vietnamese industrial facilities would eliminate the fruit of several hundred million dollars in capital investment, cut off the source of perhaps one-quarter or more of the gross national product and most foreign exchange earnings, and could halt the construction of additional modern plants in North Vietnam by other Communist countries. It would also disrupt the functioning of other sectors of the economy through the loss of electric power and such materials as cement and some fertilizers and chemicals, add to the burden of aid from the Communist countries, and produce at least temporary displacement of the urban labor force.

3. A graduated, selective program beginning with air attack against all the facilities in one industry component (such as all powerplants) probably offers a more promising vehicle for the application of pressure against the North Vietnamese regime than a widespread escalation against

* For a detailed list of these targets, see Table B1.

numerous industrial targets in a variety of industries. Such a program not only would maximize the economic and military impact of the attacks but also would provide Hanoi with a continuing opportunity for second thoughts. If Hanoi failed to react, the completion of the total program would deal a serious blow to North Vietnam's hopes for economic progress and status, negating a decade of intense effort devoted to the construction of modern industry.

4. Modern industry in North Vietnam -- machinery, chemical, fertilizer, cement, and electric powerplants -- makes a contribution to the military capability of the North Vietnamese and Viet Cong forces in South Vietnam and to the air defense capability in the North, but this contribution is not vital. The essentially agrarian nature of the economy together with numerous local and handicraft facilities, which reportedly meet 70 percent of the population's demand for consumer goods, provides a strong buffer against economic collapse.

5. The deficit of essential economic goods needed to sustain North Vietnam's economy and the all important military supplies which are vital to the country's air defense, as well as to the maintenance of large scale aggression in South Vietnam, all come from other Communist countries. In the absence of an effective program for the interdiction of the transport system, it is expected that the flow of imports would increase. A successful air attack on all of the modern industry facilities listed in paragraph one above could increase import requirements by as much as 500,000 tons above present levels. The combined current capacities of the sea and land routes leading to North Vietnam could sustain this flow.

6. The experience in the Korean war -- the most relevant one for comparison -- suggests that the loss of modern industry may not be a decisive factor, by itself, in critically reducing the will to persist, at least as long as the abundant flow of war-supporting supplies continues.

25X1

Table B1

Selected Industrial Installations in North Vietnam

25X1

<u>JCS Target Number</u>	<u>Industrial Installation</u>
Electric power <div data-bbox="321 646 459 898"></div>	Hanoi Powerplant Haiphong Powerplant (cement) Haiphong Powerplant Viet Tri Powerplant Thai Nguyen Powerplant Bac Giang Powerplant Hon Cai Powerplant
Manufacturing plants <div data-bbox="329 972 446 1402"></div>	Haiphong Cement Plant Bac Giang Chemical Fertilizer Plant, Ha Bac Lang Chi Explosives Plant Hanoi Rubber Products Plant, Sao Vang Viet Tri Chemical Plant Hanoi Engineering Plant Tran Hung Dao Engineering Plant Haiphong Machinery Enterprise, Duyen Hai Hanoi Electrical Engineering Plant
Metallurgy <div data-bbox="342 1503 410 1570"></div>	Thai Nguyen Iron and Steel Complex
Mining * * *	Hon Gai Coal-Processing Plant Cam Pha Coal-Processing Plant Vang Danh Coal-Processing Plant

* Not on JCS Targeting List.

25X1

I. Electric Power Industry

A. Significance to the Economy

The most important sector of North Vietnam's electric power generating industry consists of the network centered on Hanoi and Haiphong. The present capacity of this net is 104,500 kilowatts (kw), made up of seven plants, one of which is operating at half capacity because of bomb damage. Aerial attacks have already denied North Vietnam 83,000 kw of capacity in all geographic areas.

Hanoi's power supply comes from one large (32,500 kw) local plant in poor condition and from supplemental power from the grid's transmission network. Haiphong receives electric power from two local plants (combined capacity, 17,000 kw) in poor condition and from the transmission network. Remaining powerplants that still feed the network are located at Viet Tri, Thai Nguyen, Bac Giang, and Hon Gai.

In addition to the main power network, two small independent power systems are located in the southern part of North Vietnam. Powerplants in both systems have been heavily damaged, and all central facilities located in the two systems are now out of operation. Thus far, US airstrikes against the power industry have been concentrated on these two systems which serve little industry and whose powerplants are of small economic significance. Twenty-six out of 42 strikes have been carried out against plants at Thanh Hoa, Co Dinh, Ban Thach, and Ben Thuy. These plants had accounted for 8 percent of total national generating capacity.

Neutralization of about one-third of North Vietnam's power industry has not yet greatly affected the economy. Losses of generating capacity have eliminated margins of reserve capacity but have not significantly curtailed the power supply for industry, because the major part of modern industry is concentrated in the Hanoi-Haiphong region.

The margin of reserve generating capacity available in the northern grid prior to the beginning of airstrikes apparently has been eliminated. Industrial demands probably could be generally fulfilled even after a loss of an additional 10 percent of the generating capacity still intact. However, it probably would become necessary to stagger work shifts and eliminate nonessential consumption by residential-commercial users, public lighting, and transportation. Any further significant loss of generating capacity would almost certainly reduce the power supply for industry.

The persistence of efforts to restore damaged power facilities underlines the importance of these plants to North Vietnam and strongly suggests that no suitable alternative to central generating plants has been found. Mobile generating units, imported by the hundreds during the past 18 months, apparently have not adequately offset the loss of central generating facilities. Most of the mobile generating units are small-sized (16 to 100 kw) and designed for low voltage generation, and for that reason are not suited to supplying power through the existing transmission network. They are well-suited for independently supplying power to small essential services such as command posts, communication centers, and hospitals. A few of the larger mobile units probably have been used to supply small amounts of power to industrial consumers. From the sizes and total capacity of mobile units imported thus far, however, significant reliance on such units for industrial power is highly unlikely.

B. Future Targets

North Vietnam's main power network can be crippled and most of its important industry can be put out of operation by successful air-strikes against seven large JCS-targeted powerplants still operating in Hanoi, Haiphong, Viet Tri, Thai Nguyen, Bac Giang, and Hon Gai. These plants, except for those in Hanoi and Haiphong, are all located in relative isolation from concentrations of population. They represent a capital investment of about \$30 million.

The immediate effect of successful neutralization would be a virtual shutdown of production by major units of modern industry in North Vietnam.

The Hanoi and Haiphong local powerplants are equipped with machinery 30 to 40 years old, but the capacities are large, and by themselves could supply from one-half to two-thirds of the local demand when operated at capacity. Powerplants located in Hanoi and Haiphong are closer to concentrations of population, and because of this, a greater political hazard is involved.

The impact of the postulated attacks on powerplants can be maximized by carrying out strikes simultaneously. This tactic would diminish any possibilities for scavenging and cannibalizing undamaged equipment for use elsewhere and would overwhelm North Vietnamese capabilities to reconstruct the facilities by creating general shortages of materials and technicians. It is estimated that attacks on small powerplants and the numerous agricultural powerplants located about the country would amount to no more than a form of harassment.

C. Recuperation

North Vietnamese reaction to successful attack on its remaining powerplants probably would be reflected in attempts to purchase large diesel-driven generating equipment, as opposed to the hundreds of small diesel units imported thus far. This is the only alternative to reconstruction of central generating facilities, and, even here, the order, delivery, installation and testing would take about four months initially. In any case, it appears highly unlikely that large diesel units could offset more than a small fraction of the power lost from central generating facilities.

Several facts argue against the use of large diesels on a grand scale. Heavy diesel equipment requires frequent and continuing maintenance and a reliable channel for spare parts. Experience in Cuba demonstrates the rapidity with which deterioration sets in when requisite maintenance cannot be performed. For North Vietnam, an additional problem would be inadequate numbers of diesel technicians, and any large import of heavy diesel equipment would most likely be accompanied by foreign technicians to service and operate them.

II. Manufacturing Plants

A. Haiphong Cement Plant

The Haiphong Cement Plant was built in 1899 and rebuilt to its present annual capacity of 700,000 tons after World War II. The present estimated replacement cost of the plant is \$30 million.

The plant produced 650,000 tons of grey portland cement in 1965. This amount satisfied all in-country needs and an estimated one-third of this output was exported. In 1966, 90,000 tons were shipped from Haiphong, principally to Cambodia, Hong Kong, and Singapore; exports to the Free World were valued at \$1.24 million. Cement is an important source of foreign exchange even though exports declined. Although the data are lacking on exports to Communist countries, it is believed that at least 100,000 tons were shipped to Communist China in 1966, possibly for re-export.

Cement is important as a basic building material in North Vietnam for the construction of buildings, civil defense shelters, bridges, and airfields. During the present bombing, it has become even more important in civil defense and construction of bridge piers and abutments. Although most of the temporary repair on bridges has used timber and stone, cement is necessary for rebuilding some abutments and installing heavy anchors or deadmen for cable bridges.

Direct military uses of cement, identified since 1965, have been small. However, airfields under construction at Yen Bay, Son Tay, and Bai Thuong will require surfacing with cement to be completed. Some underground shelters and command centers have probably been built in the Hanoi area using cement.

A steady source of electric power is vital to keep the large rotary kilns and grinding mills continually operating. Any sudden stop in the operation of a kiln would cause it to buckle because of the intense heat continually being fed into it to produce the clinker from which powdered cement is eventually obtained. Each of the rotary kilns, therefore, has its own auxiliary power supply. However, it is doubtful that the auxiliary power units could operate the plant continuously if the main supply of electric power were neutralized.

The plant is located in the northeast section of Haiphong City on the south bank of the Cam Estuary about 0.5 mile west of the Chamber of Commerce docks. A thermal powerplant [] which also supplies its surplus electric power to Haiphong City, is in the same complex south of the rotary kilns. The southern boundary of the plant is Route 5 which runs from Haiphong to Hanoi. Civilian housing abuts the northwest, south, and southeast boundaries of the plant and appears to be heavily concentrated. On the opposite bank of the Cam Estuary is a hospital. The main target would be the seven rotary kilns located in the north-central part of the complex. The plant covers about 39 acres and employs about 4,500 workers, 7 days per week in 3 shifts. Reportedly, women make up one-third of the work force.

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It would be impractical to disperse the production facilities of the Haiphong Cement Plant. The size of the key production units is too large to allow dispersal. The seven rotary kilns range in size from 280 to 375 feet in length and are 8 to 10 feet in diameter.

If the rotary kilns were heavily damaged, it would take at least a year to restore partial output and up to three years to completely restore the plant. It has been estimated that perhaps 400,000 tons of cement would have to be imported to satisfy annual current North Vietnamese requirements.

B. Ha Bac Chemical Fertilizer Plant (Bac Giang)

This new plant, built with aid from China at a cost of about \$20 million, may be completed and about to begin production of ammonium nitrate fertilizer. Although this facility has purely economic significance,

it can properly be regarded as a military target. Ammonium nitrate is an explosive which can be used for demolition work or mixed with TNT for loading in shells. Moreover, the plant will produce nitric acid -- a vital input to various explosives and an oxidizer for the surface-to-air missile system.

Neutralization of production facilities (for example, nitric acid, ammonia synthesis, and boilerhouse) would impose economic difficulties on the North Vietnamese. Its capacity for production of ammonium nitrate, 100,000 tons per year, constitutes about 37 percent of the current national capacity for chemical fertilizers (exclusive of apatite and ground phosphate rock). Plans call for eventual doubling of its production capacity at this plant.

As a potential source of military explosives, this plant would be an imposing addition to North Vietnam's small munitions industry. Its loss, therefore, would constitute a serious obstacle to North Vietnam's objective of attaining greater self-sufficiency (and accordingly less dependence on outside support) for explosives and other military products. However, the supply of explosives and ammunition could continue to flow from China and the USSR, as it does at present, unless rail and road connections with China were seriously interdicted.

Bombing of this facility in the near future would involve less loss of life to civilians than it would after full operation is reached, because it seems unlikely that a large workforce is at present in the plant area. Major damage to the plant at this juncture conceivably could stave off its future expansion.

If it were seriously damaged, it seems doubtful that the North Vietnamese could repair the plant on their own. Imports of vital pieces of equipment and technical assistance could be obtained from Communist China or the USSR, but considerable time and cost would be involved in restoring the facility. If North Vietnam considered an amount of ammonium nitrate equivalent to the planned output of the Ha Bac plant to be vital, Hanoi would need to expend about \$8.3 million annually. About 30 ships would be needed to carry the quantity of fertilizer involved if the Hanoi regime decided to import an equivalent volume of fertilizer or explosive.

C. Lang Chi Explosives Plant

In August 1965 the Lang Chi Explosives Plant sustained considerable damage which probably curtailed output in subsequent periods.

There is no indication that the damaged facilities have been repaired or that output has resumed at this plant. Although no follow-up bombing of this facility seems to suggest itself at the present juncture, this target should be reviewed on a continuing basis for evidence of repair and revitalization of its munitions production.

This plant, valued at an estimated \$8.5 million, supplied a relatively small part of North Vietnam's explosive requirements, most of which are imports.

D. Sao Vang Rubber Products Plant (Hanoi)

The Sao Vang Rubber Products Plant is North Vietnam's only producer of rubber products, some of which, by North Vietnamese admission, are for military purposes. The output plan for 1965 called for 23,000 motor vehicle tires, including those used on trucks. This is believed to be only a small portion of the plant's capacity for production of tires and other rubber products. The regime acknowledges that the plant has experienced "unparalleled difficulties," possibly attributed in part to war-induced supply problems but probably due more to problems with machinery and equipment. The sharp drop in imports of natural rubber of over 40 percent in 1965 and 1966 implies that output at this plant has been cut back severely in recent periods and may now consist primarily of essential products for defense and other uses.* Thus, while the plant is not currently on

* North Vietnam's imports of natural rubber have declined significantly in recent years, probably signifying a down-turn in output of rubber products. Imports of synthetic rubber probably are slight. Although complete statistics on rubber imports in 1966 are not available, it is estimated that they did not exceed 4,000 tons, about \$2.1 million. This would represent a drop of about 40 percent from imports in 1965, which amounted to about 6,600 tons (\$3.7 million). Coincident with this decline in imports of natural rubber, North Vietnam's purchases of finished rubber products, notably tires, are believed to have increased significantly involving an additional outlay of over \$600,000. Imports of rubber products from other countries presumably also increased substantially in 1966 and the total additional cost of imports probably was well in excess of \$1.6 million, the amount by which imports of natural rubber declined.

the JCS target list, it is a legitimate war-supporting installation for targeting. It is located in a suburban industrial section of Hanoi, adjacent to the Hanoi Engineering Plant. There are worker housing installations and a school in the area. Some passive defense measures have probably been taken to protect the plant and its labor force. Neutralization of this facility would impose a small additional import burden to satisfy war-supporting requirements because most tires and other rubber products are currently supplied by the USSR, China, and other Communist nations.

E. Viet Tri Chemical Plant

The Viet Tri Chemical Plant, currently on the JCS target list, is referred to as "the first child of the chemical branch" and the country's sole producer of chlorine, caustic soda (used in paper production), hydrochloric acid, insecticides, and polyvinyl chloride. Chlorine is used in the production of insecticides, in metallurgical processing, in bleaching textiles, and in water purification. It was built with Chinese aid and began production in 1962 as part of a complex which includes a power plant, a paper mill, and a sugar refinery. The plant is valued at an estimated \$5 million, although the current economic significance of the facility is believed to be considerably greater.

Although North Vietnam reports that dispersion of this plant has taken place, it seems unlikely that the vital operations have been shifted to other locations. Information as of November 1966 indicated that the plant was in operation. Operation of this plant could be suspended by inflicting serious damage on the power source or the electrolytic cell building.

North Vietnam's direct loss in chemical production would amount to several million dollars per year. Chlorine could be imported, but this would be difficult because it is a hazardous item to transport. In all probability the North Vietnamese would resort to importing the finished products (insecticides, plastics, and the like) previously produced at the plant to the extent that these were essential for war support.

The civilian personnel in the target and adjacent areas are estimated to number under 3,000. These personnel include a number of factory employees who are termed "self-defense," or paramilitary forces.

F. Machine Building

The most important and largest machine building plants in North Vietnam are the Hanoi Engineering Plant, the Tran Hung Dao Engineering Plant in Hanoi, and the Duyen Hai Machinery Enterprise in Haiphong. These plants account for an important share of the output and repair of machinery in North Vietnam. In 1964 the machine building industry of North Vietnam met 20 to 30 percent of the needs of the country for machinery and equipment; presumably now this percentage is much lower because of greatly increased imports of machinery in 1966.

The Hanoi Engineering Plant is the largest and most sophisticated machine building plant in the country, having been constructed as a Soviet aid project in the late 1950's and expanded with Soviet assistance in 1966. It is valued at about \$8 million and is the only machine building plant on the JCS target list [REDACTED] Production at the plant includes machine tools, vehicle parts, diesel engines, rail cars, and some steel. It is the only major producer of machine tools in North Vietnam, having an estimated annual capacity of 1,200 units. The plant employs some 3,500 personnel and is located in a built-up area. Living quarters for the factory laborers, many of whom lived in the immediate area, have been at least partly dispersed and extensive measures to alleviate the effects of airstrikes have also been taken. These measures include dispersal of some facilities, camouflage, and construction of air raid shelters and trenches, and a plan has been devised to protect equipment in the event of flooding.

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The Tran Hung Dao Engineering Plant produces agricultural implements, diesel engines, machine tools, pumps, and spare parts for vehicles. It employed some 1,300 personnel as of 1964 and has a replacement value of about \$3 million. It is not currently on the JCS target list. The defense measures described for the Hanoi Engineering Plant probably also were implemented at the Tran Hung Dao Plant. The plant is located in a heavily populated area of Hanoi not far from the center of the city.

The Duyen Hai Engineering Plant in Haiphong is known to produce boilers, fertilizer crushers, pumps, and simple machine tools. It, too, is located in a densely populated part of the city and probably has also received the benefit of many defense precautions. The plant is smaller than the major machine building plants in Hanoi.

With respect to military importance, the Hanoi Engineering Plant and the Tran Hung Dao Engineering Plant together with the Hanoi Electrical Engineering Factory and the Sao Vang Rubber Products Plant in Hanoi were singled out for praise in 1965 as producers of many new products for transportation and communications. One prisoner report claimed that the Hanoi Engineering Plant and the Tran Hung Dao Plant were producers of ammunition, but neither the construction nor the location (in populated area) conform with this possibility. It is possible, however, that casings for ammunition are manufactured there, and the plants do possess a potential capability to manufacture small arms.

There are innumerable other machine building and repair shops of various sizes throughout North Vietnam, some of which may be engaged in the manufacture of small arms. In 1961 there were more than 40,000 employees in some 350 facilities. The number has probably increased significantly, especially since the beginning of the bombing, to provide greater regional self-sufficiency and faster maintenance for the transportation system. This buildup has been accomplished through dispersal of existing shops from urban or heavily bombed areas as well as through the setting up of new shops.

Machine building and repair facilities lend themselves more easily than other heavy industrial facilities to dispersal, inasmuch as much of the capital equipment can be operated independently. This feature would also enable at least partial production to continue with the aid of small electric generating units. A large share of the heavy volume of imports of spare parts and machine tools for the manufacture of spare parts probably has been distributed to new or existing shops in the countryside near the important lines of communication. A contract signed with Rumania in 1966 for the import of five regional machine shops and an apparent agreement by East Germany to supply an automotive repair shop probably are not the only instances in which Communist countries are supplying "small" but complete facilities.

The smaller local facilities -- not all of which necessarily fall under the category of machine building plants -- also are the most important producers of the more primitive transportation equipment, including bicycles, carts, junks, sampans, and motorboats. The assembly of barges and ferryboats is carried out on a limited scale as is the fabrication of small containers for petroleum products. The existence of such a large number of machine shops, however, would only partly alleviate the loss of the three largest plants. Production of the larger, more sophisticated machinery could not be taken over

by local facilities which would retain their main functions as suppliers of small agricultural equipment and providers of local repair capability. The dependency on imports of heavy equipment would become absolute. The loss of the main machinery plants would probably suggest to North Vietnam's Communist allies that the supply of heavy industrial equipment, other than transport and construction equipment, to North Vietnam during the course of the bombing would be irrational. In this case, a decrease in such supply rather than an increase would be possible. The destruction of any large industrial facility, such as one of the machine building plants noted above, probably would remove any remaining North Vietnamese hopes for industrial development for the duration of the air war.

III. Iron and Steel -- Thai Nguyen

A. Introduction

The construction of the first stage of the integrated steel mill at Thai Nguyen is nearing completion. This plant, currently on the JCS target list, includes the following facilities: one coke oven battery; a coke byproducts section; three blast furnaces with an estimated annual capacity of 100,000 tons each, an open-hearth furnace building; a rolling mill; and a refractory brick plant. Fabrication areas and storage, support, and associated administrative buildings complete the installation. Ancillary facilities include new roads and rail lines and other installations for receiving and handling raw materials and for shipping products. The North Vietnamese estimate that the total investment for the entire complex will amount to about \$160 million.

Recent aerial photography of the Thai Nguyen area indicates that the plant is only partly operational. There are no indications that either the steelmaking furnaces or the rolling mill facilities are operating. The output from the three blast furnaces in 1966 is estimated at 100,000 to 150,000 tons, about 50 percent of capacity. Structural steel members and prefabricated liquid storage tanks have been observed in the yards, indicating that the plant is receiving imported semifinished steel for further fabrication. The materials observed include pontoons, truss panels, plate girders, rails, and other materials of similar size. With the exception of the storage tanks and pontoons, all steel fabrications observed are judged to have been assembled primarily for use in the construction of buildings at the Thai Nguyen plant.

The plant layout was designed for future expansion on a two-stage building program. At the present time the facilities for stage one, which are nearing completion, provide for the annual production of 100,000 tons of crude steel. Construction of the second stage is planned to raise the total annual capacity for crude steel to 200,000 tons, presumably by 1970.

When the three blast furnaces are at full capacity, which is not likely to be achieved until the open-hearth furnaces are capable of converting their output to steel, the output of pig iron at the Thai Nguyen plant could reach 300,000 tons annually. Depending on the availability of scrap, maximum consumption of the output of pig iron in the production of steel at that plant would amount to only 130,000 tons. This would leave upwards of one-half (150,000 tons) of the output of pig iron available for export or for consumption in the manufacture of iron castings, including cast iron wheels for railroad cars.

Sufficient casting and rolling capacity is planned to allow conversion of the crude steel output into usable finished steel products. Initially, the rolling mills are to produce wires, reinforcing rods, and structural shapes. Ultimately, facilities are to be added for the manufacture of sheets and pipe. On the basis of the maximum output of crude steel, the annual production of finished steel products would amount to 150,000 tons.

Except for coking coal, North Vietnam has adequate reserves of the raw materials required to support the planned output of the new iron and steel plant. Iron ore is of relatively good quality and available from a nearby area. Manganese ore and limestone also exist in sufficient quantities. The necessary requirements for coking coal, although limited domestically, are readily obtainable from Communist China.

B. Significance to the Economy

Contributions to the North Vietnamese military effort by the Thai Nguyen iron and steel plant currently are limited. Producing only pig iron, the plant provides cast iron wheels for railroad transport and probably other iron castings, for restricted use on military vehicles and earthmoving equipment. Other cast iron materials that could contribute to the war effort are small tools, pipes and tubes, and hand grenades, but there is no evidence that such items are being produced at Thai Nguyen.

The main contribution to the economy of North Vietnam by the Thai Nguyen plant thus far has been as an earner of foreign exchange. Exports of pig iron from North Vietnam reached a peak of about 58,000 tons in 1965, but since then have declined considerably. The estimated volume and value of these exports of pig iron from North Vietnam for the years 1964 through 1966 are shown in the following tabulation:

<u>Year</u>	<u>Tons</u>	<u>Thousand US\$</u>
1964	28,317	1,349
1965	57,745	2,784
1966	39,600	1,910

Since 1964, about 90 percent of North Vietnam's exports of pig iron have gone to Japan, with the remainder going primarily to Hong Kong and Singapore.

The value of production of that portion of output of the Thai Nguyen plant consumed domestically is difficult to assess. Recently the output of pig iron has been divided approximately equally between domestic use and exports. Assuming a value per ton for the pig iron consumed domestically equal to that which is exported, the value of production consumed in the local economy (1966) is estimated to vary between \$3 million and \$4.5 million.

C. Impact

Destruction of the Thai Nguyen iron and steel plant by bombing would not result in significant impairment of the current military operations of North Vietnam. Losses to the war effort at the current stage of output of the plant would be limited to wheels for railroad cars, such iron castings as might be used in military vehicles and equipment, and possibly hand grenades, if the plant is producing them. Industry and transportation would also lose some significant fabrication and assembly capacity for various types of equipment.

The principal economic loss to North Vietnam, if the Thai Nguyen plant were to be severely damaged, would be the loss of foreign exchange resulting from the exports of pig iron. The principal military loss is hard to quantify. Certain of the fabrications produced by this plant, such as pontoons, have either a direct military or logistic

use. However, it has not been possible to quantify this dependence, other than to note that it must be relatively small.

Regarded by the North Vietnamese as one of the most notable advances in the industrial development of the country, the planned achievements of the plant are an essential part of the country's economic future. As an industrial process, it is a distinct improvement over anything that has been attempted by the North Vietnamese to date, incorporating modern equipment and technology. Hence its loss at this time would constitute a distinct blow to the hopes of the Hanoi regime for achieving rapid industrialization, perhaps until the end of the war.

However, Thai Nguyen is in an unusual position. The operation of its blast furnaces requires the import of 150,000 to 200,000 tons of coking coal from China. The mining of the ports, on the other hand, would eliminate most exports -- certainly hard currency exports -- and hence Thai Nguyen's principal value to Hanoi at present. If the mining of Haiphong and other ports is carried out, there would be advantages to leaving Thai Nguyen in operation. This would be because of the need to try to supply it with 150,000 to 200,000 tons of coking coal from China by rail.

IV. Mining

A. Coal

Anthracite coal is North Vietnam's major source of energy and its most valuable export. The entire needs of the country are met by domestic production, with the exception of some 150,000 to 200,000 tons of coking coal imported from China. The major consumers of coal are the large industrial facilities, including the electric powerplants. Coal is not important to the military effort of North Vietnam nor to the general population, because of the mild climate. The requirements of the rail system are also very small. Total output of coal in 1965 is estimated at about 4 million tons. Some 1.9 million tons, valued at about \$30 million, were exported.

From 80 to 90 percent of North Vietnam's coal is mined near the ports of Hon Gai and Cam Pha. A new mining center, including a preparation plant, was probably completed at Vang Danh near Port Redon late in 1966. This facility will become of increasing importance in the future. The ports and loading facilities near the mines are vital both for foreign trade and for internal

distribution inasmuch as the mines do not have rail connections to the rest of the country.

The mines themselves are unpromising targets for air attack because of their relative dispersion. Neutralization of the coal-preparation plants at Hon Gai, Cam Pha, and Vang Danh, however, would eliminate the export earnings from coal, and neutralization of the loading and conveying system at the ports -- Hon Gai, Cam Pha, and Port Redon -- would disrupt trade and internal distribution. The requirements of at least priority domestic industrial facilities probably would still be met through supplies from local mines scattered throughout the country and unprepared coal from the large mines. If the major industrial plants and electric powerplants were severely damaged, domestic requirements would be substantially reduced. Hence, the main benefit from successful attack on the coal-processing facilities would be the loss of hard currency foreign exchange, which has run about \$8 to \$10 million a year. Coal sales have accounted for as much as 55 to 60 percent of North Vietnam's hard currency foreign exchange earnings. More recently, bomb damage to Cam Pha has reduced this amount.

V. Impact on Imports

Although the precise nature of the import program that would follow a successful attack against modern industry is uncertain, it is estimated that the required level of annual imports could increase by as much as 500,000 tons. This increased volume of import requirements, if fully met by North Vietnam's Communist allies, would cost about \$500 million. However, it would require utilization of less than one-half of the total transport capacity available to North Vietnam at present. Although port capacities are heavily utilized, there exists slack in the rail and road connections to China, particularly the latter. The estimated increase in imports is assumed to include sufficient cement, fertilizer, pig iron, machine tools, spare parts, medicines, and the like to replace essential production for domestic consumption.

A. Imports and Exports in 1965-66

North Vietnamese imports in 1966 increased substantially over the 1965 level in both value and volume. During the same period, exports decreased considerably. The increased imports were financed mainly by aid and grants extended to North Vietnam by Communist countries in 1965 and the first part of 1966. The value of the goods delivered to North Vietnam by Communist countries jumped sharply in 1965 and increased again in 1966, from about \$115 million in 1964, to an estimated \$410 million in 1965 and \$505 million in 1966. The following tabulation shows the division of the total value of these deliveries between military and economic aid:

	<u>Million US\$</u>		
	<u>1964</u>	<u>1965</u>	<u>1966</u>
Military	40	260	230
Economic	75	150	275
Total	<u>115</u>	<u>410</u>	<u>505</u>

Military aid deliveries declined in value as deliveries were completed of integrated defense systems and major pieces of equipment such as aircraft and naval craft. It is believed that military deliveries in the latter part of 1966 consisted mainly of replacements, spare parts, and ammunition.

North Vietnamese imports of economic goods from the Communist countries have generally been the type that would aid economic development and growth and include complete plants, transportation and construction equipment, machinery, petroleum, and light manufactured goods. Although most of these goods were primarily destined for industrial development, a large portion of the goods, especially transportation and road construction equipment and petroleum, contributed to North Vietnam's military capability as well. Consumer goods account for only a small quantity of imports, and food in the form of aid has not been a significant item, except possibly from China. The types of economic goods sent to North Vietnam by the Communist countries did not change significantly in 1966, but the quantity has increased substantially.

The total volume of imports by sea and land in 1966 is estimated to have been about 1.5 million tons, an increase of about 30 percent, compared with 1965. The proportion of the total moved by international shipping and by railroad remained about the same as in 1965. The import data, as shown in the following tabulation, include the identified seaborne imports and an estimate of the seaborne imports that were probably carried on Chinese and North Vietnamese ships moving between China and North Vietnam.

	<u>Thousand Tons</u>	
	<u>1965</u>	<u>1966</u>
By sea (including petroleum in bulk)	850	1,080
By rail	320	420
Total	<u>1,170</u>	<u>1,500</u>

Information on the identified seaborne imports, by major commodity group and by country of origin, is shown in Table B-2. Identified imports increased for all major commodity groups, except foodstuffs and timber. The largest percentage increase occurred in the miscellaneous category. Table B-2 reveals that the volume of identified North Vietnamese seaborne exports declined by about 35 percent in 1966, compared with 1965. The decline in the volume of commodities exported through Haiphong -- apatite, cement, pig iron,

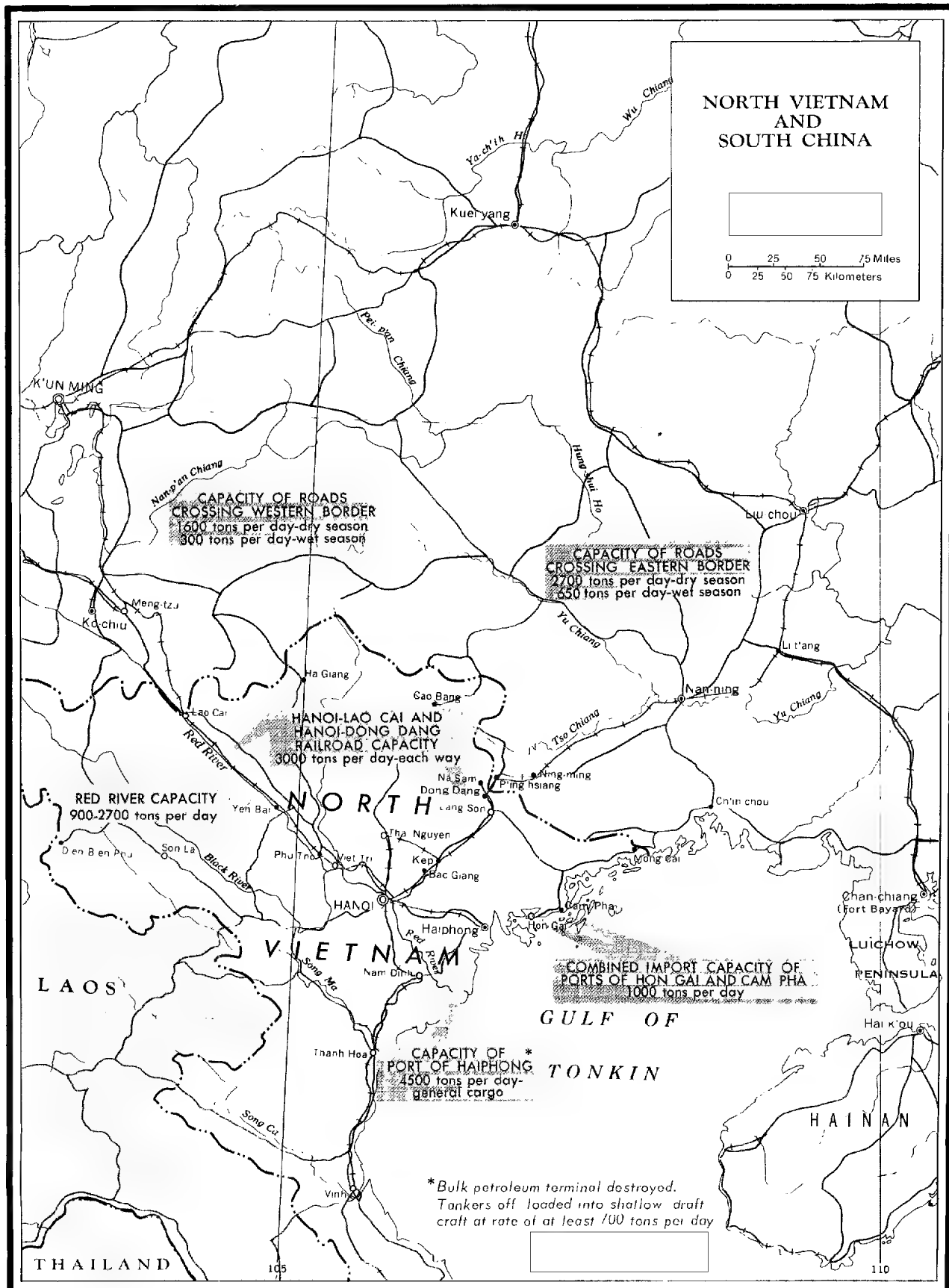
and miscellaneous goods -- was much greater than the decline in the export of coal which moves through other ports. Table B-4, which presents the estimated seaborne trade by port of entry, reveals that the volume of dry cargo moved through Haiphong declined by nearly 15 percent in 1966, compared with 1965. The volume of imports increased while exports decreased, with the result that imports accounted for more than 75 percent of the cargo handled at Haiphong.

Estimates of imports by rail, as shown below, indicate that about 45 percent of the volume imported in 1966 probably consisted of military goods, about 40 percent was coal for the blast furnaces at Thai Nguyen, and about 15 percent was miscellaneous economic goods.

	<u>Thousand Tons</u>	
	<u>1965</u>	<u>1966</u>
Military	100	180
Coal	165	165
Other economic goods	55	75
Total	<u>320</u>	<u>420</u>

B. Transport Capacity Compared with Import Traffic in 1966

Using land and sea routes at their present capability, North Vietnam can import about 5 million tons a year, or a daily average of about 13,800 tons (see Table B-5 and Figure B-1). The major ports account for about 40 percent of the total capacity, land routes from Kwangsi Province in China to Hanoi account for 35 percent, and land and water routes from Yunnan Province account for the remaining 25 percent. This capability could be considerably increased within a relatively short period of about two months by repairing interdictions on the Hanoi-Lao Cai rail line, by improving the roads, and by obtaining foreign assistance in the ports to better organize cargo-handling and port-clearance procedures. The above estimate of the North Vietnamese capability to import does not include an estimate of the quantity of cargo that could be offloaded from oceangoing ships into shallow-draft craft for movement to the beaches or to small ports. The North Vietnamese probably have considerable capability to handle dry cargo in this manner. They have already demonstrated that they can receive petroleum from tankers in this manner at the rate of at least 20,000 tons a month, or 700 tons a day.



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Figure B-1. North Vietnam and South China: Uninterdicted Capacity of Selected Transportation Lines, January 1967

In 1966, North Vietnamese imports of dry cargo utilized about one-fourth of the overall capacity and about 50 percent of the capacity of Haiphong port and the Dong Dang-Hanoi railroad line -- the two routes normally used for the majority of the imports.

1. Ports

Deep-draft international ships normally call at only three North Vietnamese ports -- Haiphong, Cam Pha, and Hon Gai (see Figure B-1) but only Haiphong is served by North Vietnam's rail network. Haiphong is the principal maritime port for nearly all seaborne imports and all the seaborne exports except coal. The port has a theoretical capability to handle about 4,500 tons a day of dry cargo. Prior to the bombing of the petroleum storage facilities in 1966, Haiphong also had the capacity to handle about 900 tons a day of petroleum in bulk.

In 1966, estimated tonnages of dry cargo, including packaged petroleum, moving through the port averaged about 3,100 tons a day, or about three-fourths of capacity. Of the total, 2,390 tons were imports and 710 tons were exports. If North Vietnam were to forgo exports, Haiphong port theoretically could handle dry cargo imports at the rate of 4,500 tons a day. During 1966, however, irregular arrivals of ships and inability of surface transport to clear the port area of cargo resulted in delays and congestion. Also a factor that may have contributed to the congestion was the large volume of miscellaneous cargo imported (see Table B-2). With some foreign guidance and additional cargo-handling equipment for use on the dock, however, it is quite possible that the North Vietnamese could achieve the theoretical capacity of Haiphong port.

Cam Pha and Hon Gai handle only one significant cargo, anthracite coal for export. About 90 percent of the seaborne coal exports originate in Cam Pha, which is the only coal port able to accommodate large ships at its dock. Both ports have limited wharf and storage facilities for general cargo, which consists almost exclusively of supplies for the mines and their small worker communities. In 1966, about 24,000 tons of imports were identified as being offloaded at Hon Gai. If the wharf area usually used for loading coal were used to receive cargo, these ports would have considerable capability to accept cargo offloaded with ship's gear. Surface transport to clear the port is limited to truck transport on a poor quality road. Thus, coastal water transport would have to be used to some extent, depending on the condition and use already being made of the road.

2. Railroads

The uninterdicted capacity of the Dong Dang-Hanoi railroad, which carries most of the North Vietnamese foreign trade moved by land transport, is estimated to be 3,000 tons each way per day. Through traffic on the line was interrupted for a total of about two months during 1966, but some international traffic continued to move even during periods of interdiction. Thus the loss of daily capacity on the average throughout the year probably was quite small. Imports on this line during 1966 are estimated to have increased to about 420,000 tons (1,200 tons per day), compared with 320,000 tons in 1965. About 40 percent of the 1966 imports probably consisted of coal for the Thai Nguyen blast furnaces, about 45 percent were military supplies, and the remainder miscellaneous goods. Thus the imports moved on this line in 1966 amounted to less than one-half of capacity of the line to move imports and about one-half of the amount moved was economic goods that would probably be considered of low priority if there were a shortage of transport capacity.

Although the overall capacity of the Dong Dang line itself continues to be about 3,000 tons, railroad construction in 1966 provided an alternate route for the portion of the line between Kep and Hanoi. The standard-gauge line was completed between Kep and Thai Nguyen and presumably is in service. Thus imports can now move from Kep to Hanoi via Thai Nguyen. Furthermore, probable installation of a third rail on the Dong Dang-Kep line to make it dual gauge may now be facilitating the movement on standard-gauge freight cars of imports from China as far as Kep and Thai Nguyen.

The Lao Cai-Hanoi railroad line normally has the capability for about 3,000 tons each way per day. The destruction of the railroad/highway bridge at Viet Tri has reduced the present through capacity of this line to an estimated 600 tons each way per day. Traffic at Viet Tri now utilizes two rail car ferries and a pontoon highway bridge. Apparently the capacity of these facilities is sufficient to meet the requirements for traffic on the line. The North Vietnamese have repaired or built bypasses for bridges of equal or greater length. If they need more capacity on this line, however, they could repair the bridge in a maximum of two months. Capacity could be increased in less than two months by the use of more ferries and other alternate facilities.

This rail line as well as road and water routes from Yunnan Province became more significant in 1966 as alternate routes for North

Vietnamese imports as a result of the completion of the railroad line within China to connect Yunnan Province with the main Chinese rail system. North Vietnamese imports can now be moved more easily to the K'un-ming area and thence to North Vietnam.

If China provides rolling stock to North Vietnam, equipment to utilize the North Vietnamese railroads to capacity should be no problem in spite of the considerable destruction of rolling stock by bombing. Meter-gauge equipment is available in Yunnan Province, and it is possible that standard-gauge equipment is now in use as far as Kep and Thai Nguyen.

3. Roads

At present, only small amounts of cross-border, short-haul foreign trade move by truck between North Vietnam and Communist China. The estimated total capacity of the roads that cross the border and lead to the Hanoi-Haiphong area is 4,300/950* tons per day. A little more than 60 percent of this total is accounted for by roads that cross the eastern border of North Vietnam (from the Nanning, Canton, and Fort Bayard areas) and the remainder by roads that cross the western border. The road capacity from Hanoi to Haiphong is estimated to be about 1,150/400 tons per day.

At present North Vietnam does not have enough trucks and repair facilities to utilize the roads to capacity for imports while continuing the present level of truck transport activities. Utilizing the roads to capacity would require possibly 5,000 to 6,000 trucks daily. Communist China, with an inventory of over 200,000 trucks, could make this number available.

The only inland waterway route that could contribute significantly to the movement of supplies across the border between China and North Vietnam is the Red River. Little if any imports are moved on this route at present. It is estimated to have the capability for 900 tons a day during low water and 2,700 tons a day during high water.

* The figures separated by the slanting line show estimated minimum capacities between terminal points under the best and worst climatic conditions.

Table B2

North Vietnam: Identified Imports Carried by Foreign-Flag Ships
by Origin and Commodity a/
1965-66

Thousand Tons

Origin	1965						1966					
	Ammonium Sulfate and Other Fertilizers	Petroleum	Grain and Other Foodstuffs	Timber	Miscellaneous	Total	Ammonium Sulfate and Other Fertilizers	Petroleum	Grain and Other Foodstuffs	Timber	Miscellaneous	Total
Total	162.4	170.2	118.6	14.5	231.4	697.1	224.3	200.8	77.1	13.6	416.2	932.0
Communist countries	118.2	170.2	59.0	0	201.7	549.1	176.9	200.8	65.3	0	373.8	816.7
USSR	78.5	154.8	0.7		114.9	348.9	117.8	198.2	6.4		171.1	493.5
Eastern Europe	9.0	2.0	20.4		14.2	45.6	16.0	2.6			66.0	84.5
Communist China <u>b/</u>		13.4	17.1		67.3 <u>c/</u>	97.7			37.2		118.7 <u>c/</u>	155.9
North Korea	30.7				5.1	35.8	43.0				18.0	61.0
Cuba			20.8		0.2	21.0			21.7			21.7
Free World	44.2	0	59.6	14.5	29.7	148.0	47.4	Negl.	11.9	13.6	42.4	115.3
Cambodia			14.5	14.5		29.0			10.0	13.6		23.6
Hong Kong <u>b/</u>			0.8		3.5	4.3					0.03	0.03
Japan	3.4				14.3	17.7	16.9	Negl.			30.3	47.2
Singapore/Malaysia			10.0		5.3	15.3			1.9		8.1	9.9
Western Europe	40.8		24.3		1.4	66.5	20.1	Negl.			4.0	24.2
Other			10.0		5.2	15.2	10.4				0.04	10.4

a. Because of rounding, components may not add to the totals shown.

b. North Vietnamese and Chinese Communist ships carry an additional significant volume of trade with Hong Kong and Communist China.

c. Including 38,800 tons of coking coal in 1966 and 12,700 tons in 1965.

Table B3

North Vietnam: Identified Exports Carried by Foreign-Flag Ships
by Destination and Commodity a/
1965-66

Thousand Tons

Destination	1965						1966 25X1					
	Coal	Apatite	Cement	Pig Iron	Miscel- laneous	Total	Coal	Apatite	Cement	Pig Iron	Miscel- laneous	Total
Total	<u>1,150.1</u>	<u>317.5</u>	<u>78.4</u>	<u>47.5</u>	<u>119.5</u>	<u>1,713.1</u>	<u>905.7</u>	<u>10.4</u>	<u>90.4</u>	<u>39.6</u>	<u>67.8</u>	<u>1,114.0</u>
Communist countries	<u>611.6</u>	<u>317.5</u>	<u>10.5</u>	<u>0</u>	<u>72.1</u>	<u>1,011.7</u>	<u>488.7</u>	<u>10.4</u>	<u>7.2</u>	<u>1.5</u>	<u>37.2</u>	<u>545.1</u>
USSR					42.8	42.8					11.6	11.6
Eastern Europe	10.3	183.5			14.6	208.4					16.1	16.1
Communist China <u>b/</u>	495.1	89.2	10.5		12.2	607.1	471.6	2.5	5.0	1.5	6.7	487.3
North Korea	11.8	44.8			1.6	58.2		7.9	2.2		1.3	11.4
Cuba	94.3				0.9	95.2	17.1				1.5	18.7
Free World	<u>538.6</u>	<u>0</u>	<u>67.9</u>	<u>47.5</u>	<u>47.4</u>	<u>701.4</u>	<u>417.0</u>	<u>0</u>	<u>83.1</u>	<u>38.2</u>	<u>30.5</u>	<u>568.8</u>
Cambodia			36.3		4.4	40.7			44.1		7.6	51.8
Hong Kong <u>b/</u>	11.4		6.6		14.0	32.1	4.4		11.0	0.6	8.6	24.6
Japan	443.1			37.3	10.7	491.2	346.9		7.0	36.1	3.4	393.4
Singapore/Malaysia	16.5		15.0	0.2	6.4	38.0	4.0		11.2	1.5	7.8	24.5
Western Europe	67.5		10.0		3.7	81.2	61.7				2.8	64.4
Other				10.0	8.2	18.2			9.8		0.3	10.0

a. Because of rounding, components may not add to the totals shown.

b. North Vietnamese and Chinese Communist ships carry an additional volume of trade with Hong Kong and Communist China.

Table B4

North Vietnam: Estimated Volume of Maritime Foreign Trade, by Port a/
1965 and 1966

	<u>Thousand Tons</u>		<u>Tons per Day</u>	
	<u>1965</u>	<u>1966</u>	<u>1965</u>	<u>1966</u>
Total <u>b/</u>	<u>2,610</u>	<u>2,246</u>	<u>7,150</u>	<u>6,150</u>
Dry cargo	<u>2,450</u>	<u>2,060</u>	<u>6,710</u>	<u>5,640</u>
Imports	687	896	1,880	2,450
Exports	1,763	1,164	4,830	3,190
Haiphong	<u>1,299</u>	<u>1,130</u>	<u>3,560</u>	<u>3,100</u>
Dry cargo imports <u>c/</u>	686	872	1,880	2,390
Dry cargo exports	613	258	1,680	710
Hon Gai and Cam Pha	<u>1,151</u>	<u>930</u>	<u>3,150</u>	<u>2,550</u>
Dry cargo imports (to Hon Gai)	1	24	3	70
Dry cargo exports	1,150	906	3,150	2,480
Petroleum in bulk	<u>160</u>	<u>186</u>	<u>440</u>	<u>510</u>

a. Data include the identified seaborne trade shown in Table B2 and an estimated 150,000 tons of imports and 50,000 tons of exports carried by Chinese and North Vietnamese ships.

b. Because of rounding, components may not add to the totals shown.

c. Including petroleum imported in drums on dry cargo ships.

Table B5

North Vietnam: Transport Capacity Available for Dry Cargo Imports a/
as of January 1967

	Tons per Day		
	<u>Dry Season</u>	<u>Rainy Season</u>	<u>Annual Average ^{b/}</u>
Total	<u>14,300</u>	<u>12,800</u>	<u>13,800</u>
Major ports <u>c/</u>	<u>5,500</u>	<u>5,500</u>	<u>5,500</u>
Haiphong	4,500	4,500	4,500
Hon Gai and Cam Pha	1,000	1,000	1,000
Routes from Kwangsi	<u>5,700</u>	<u>3,650</u>	<u>5,000</u>
Dong Dang - Hanoi Railroad	3,000	3,000	3,000
Roads	2,700	650	2,000
Routes from Yunnan	<u>3,100</u>	<u>3,600</u>	<u>3,300</u>
Lao Cai - Hanoi Railroad <u>d/</u>	600	600	600
Roads	1,600	300	1,200
Red River	900	2,700	1,500

a. These estimates do not include amounts that could be offloaded from oceangoing ships into shallow-draft craft and moved to inland ports or coastal ports other than Haiphong or moved over the beaches. Also no estimate is included of the amount that could be moved directly from South China ports to minor ports and beaches in North Vietnam by shallow-draft craft.

b. The dry season during which road conditions are at their best extends from about October through May. Heavy rains, beginning about May in the northern part of North Vietnam, reduce road capacity until late September. The annual average has been computed using a four-month (June-September) rainy season and an eight-month dry season.

c. Total theoretical dry-cargo handling capacity. In order for this capacity to be achieved at Haiphong, no exports could be handled. Import arrivals would have to be scheduled perfectly. Cam Pha and Hon Gai together have an estimated capacity of 2,800 tons per day to accept cargo offloaded with ship's gear, but only 1,000 tons has been entered in this table because of the problem of clearing the port. If the road that connects these ports with Hanoi were already utilized by other traffic, the ports would have to be cleared with shallow-draft coastal craft that could move to ports other than Haiphong.

d. Normal capacity is about 3,000 tons each way per day. At present the Viet Tri Bridge is not usable, but present capacity could be increased quickly by installation of additional alternate facilities at Viet Tri and the bridge could be restored in a maximum of three months.

APPENDIX C

CONSEQUENCES OF MINING THE SEAPORTS
OF NORTH VIETNAMIntroductory Note

This appendix analyzes the effects of a program of mining the sea-ports and coastal entrances of North Vietnam, including selected inland waterways, in conjunction with the semistrategic attack discussed in Appendix B.

Two alternative mining programs are examined. The first is a conventional mining program designed to prevent the use of deep-draft oceangoing ships, but which lacks a capability to prevent the use of shallow-draft craft such as coasters and lighters. The second alternative is a program using a newly developed mine with a capability against shallow-draft shipping.* Both mining programs assume the use of intensive armed reconnaissance against lines of communication (LOC's) and transport targets in order to maximize the potential effects of the program.

Conclusions

The immediate impact of either mining program would be a severe disruption of normal transport activity, ranging from a situation in which a substantial portion of imports could be maintained by sea and coastal water movements to one of almost complete denial of water access to North Vietnam.

* This mine is the MK 36, a modification of the standard MK 82 aerial bomb, which is effective against even unpowered small craft in depths up to 50 feet. It can be delivered by all aircraft capable of using the MK 82 and requires the same delivery techniques as the MK 82. The MK 36 is to go into mass production in the spring of 1967.

Although the precise nature of the import program that would follow a successful attack against modern industry is uncertain, it is estimated that the required level of annual imports could increase by as much as 500,000 tons.

Either mining program would have serious disruptive effects on the North Vietnamese transport system and the effectiveness with which it accommodates the movement of foreign trade. Almost all export trade would cease and foreign exchange earnings would become negligible. It is estimated, however, that as long as it has surplus transport capacity and adequate equipment, North Vietnam will attempt to maintain the flow of virtually all normal imports plus the import requirements generated by the attacks on modern industry. Thus the effects of the mining program will tend to be those of delay but not denial of imports.

A mining program directed solely against oceangoing shipping would increase the traffic burden on the major rail connections to Communist China to the extent that North Vietnam would be hard pressed to meet all normal traffic requirements by using rail connections. But the traffic could be handled by resorting to road and inland water routes.

A program including mining of coastal and inland waters would be much more effective. North Vietnam would have to use all existing road and rail connections at or near capacity levels. If intensive interdiction and armed reconnaissance were carried out against these vital transport links, North Vietnam would face increasingly serious problems. The vulnerability of transport equipment, the difficulties of maintaining LOC's, and the cost and unreliability of transport would all increase significantly. Some import programs would almost certainly have to be reduced. These problems alone would not be sufficient, however, to degrade meaningfully the flow of essential military and economic materials or to prevent North Vietnam's continued support of the war in the South.

I. The Dimensions of North Vietnam's Foreign Trade

A. Volume of Foreign Trade

Despite the intensified bombing program in 1966 the volume of North Vietnam's foreign trade moving by sea and by railroad declined by less than 10 percent and was still above the level of 1964. The total foreign trade of North Vietnam in 1966 amounted to about 2.8 million tons (see Table C1). About 80 percent of the total moved through the principal maritime ports -- Cam Pha, Haiphong, and Hon Gai. Most

Table C1

North Vietnam: Estimated Volume of Foreign Trade a/
1965-66

	Thousand Tons					
	Total Volume		Imports		Exports	
	1965	1966	1965	1966	1965	1966
Total	<u>3,080</u>	<u>2,816</u>	<u>1,167</u>	<u>1,502</u>	<u>1,913</u>	<u>1,314</u>
Rail	<u>470</u>	<u>570</u>	<u>320</u>	<u>420</u>	<u>150</u>	<u>150</u> <u>b/</u>
Seaborne	<u>2,610</u>	<u>2,246</u>	<u>847</u>	<u>1,082</u>	<u>1,763</u>	<u>1,164</u>
Identified	2,410	2,046	697	932	1,713	1,114
Unidentified <u>c/</u>						
Estimated additional (on North Vietnamese and Chinese ships)	200	200	150	150	50	50

a. Estimated trade moving by rail and oceangoing transport. Only a small amount moved by road and inland waterway routes.

b. Estimates of exports by rail in 1966 are only approximate, having been derived mainly as extensions of scant information for 1965.

c. The estimate is a rough approximation derived from information on the pattern and nature of trade engaged in by Chinese and North Vietnamese shipping for which specific data on cargo volumes actually carried are lacking.

of the remainder, an estimated 570,000 tons, moved overland by rail across the North Vietnamese-Chinese border. A small amount of trade moved by road and air transport.

The volume and commodity composition of seaborne trade in 1964, 1965, and 1966 are shown in Table C2.* Due to the reduced volume of exports of coal and apatite and increased imports of petroleum, fertilizer, and miscellaneous and general cargoes, imports accounted for about 45 percent of identified seaborne trade in 1966, compared with about 30 percent in 1965. Especially noteworthy were the increased deliveries from Communist countries of machinery, vehicles, rolled

* Comparable commodity data for overland trade are not available.

Table C2

North Vietnam: Identified Seaborne Foreign Trade a/
1964, 1965, and 1966

	Thousand Tons		
	<u>1964</u>	<u>1965</u>	<u>1966</u>
Total <u>b/</u>	<u>2,200</u>	<u>2,410</u>	<u>2,050</u>
Imports	<u>638</u>	<u>697</u>	<u>932</u>
Petroleum	142	170	201
Fertilizers	140	162	224
Grain and bulk food	162	119	77
Timber	32	15	14
Miscellaneous	162	231	416
Exports	<u>1,565</u>	<u>1,713</u>	<u>1,114</u>
Coal	950	1,150	906
Apatite	338	318	10
Cement	140	78	90
Miscellaneous	137	167	108

a. Additional volumes were carried by Communist Chinese and North Vietnamese ships. No estimates are available for 1964, but in 1965 and 1966 these ships probably carried an additional 150,000 tons of imports and 50,000 tons of exports.

b. Rounded to the nearest 10,000.

steel, manufactured and processed goods, and other economic aid items vital to the small modern sector of the economy and to the country's ability to absorb the impact of the air war.

The foreign trade carried by railroad in 1966 consisted of about 420,000 tons of imports and 150,000 tons of exports. Overland imports are estimated to have consisted of military supplies and equipment (45 percent), bituminous coal (40 percent), and miscellaneous economic goods. Exports by rail consisted of apatite, anthracite coal, and products of North Vietnam's food-processing and handicraft industries.

B. Level of Traffic Compared with Route Capacity

The details of the route capacities of each of the North Vietnamese transport systems were discussed in Appendix B. These systems have a combined average daily capacity of 13,800 tons. This capacity is well in excess of the daily level -- 7,700 tons -- of foreign trade moving in North Vietnam. Only the port of Haiphong, which handles almost all seaborne imports, is being used to any extensive degree, about three-fourths of its normal capacity of 4,500 tons a day. The ports at Hon Gai and Cam Pha, which are engaged almost exclusively in the coal-export trade, would have a combined capacity to handle about 1,000 tons of imports a day. The Hanoi - Dong Dang rail line which carries most of North Vietnam's foreign trade moving by land is utilized at only 40 percent of its capacity of 3,000 tons a day. With the cessation of apatite exports via Haiphong, the Hanoi - Lao Cai line has been relatively unimportant in the present patterns of foreign trade. The North Vietnamese, for example, have made no significant effort to maintain its capacity at more than 600 tons a day, compared with its normal uninterdicted capacity of 3,000 tons a day. The road and inland routes connecting North Vietnam and Communist China have a combined daily average capacity of 4,700 tons per day. These routes play an insignificant role in North Vietnam's foreign trade and are used principally for the movement of small amounts of cross-border trade.

II. Impact of Mining Under the Present Rolling Thunder Program

A. General Effects

If mining of the ports were carried out without warning, a number of foreign-flag ships might be caught in the ports.* The average

* It would be possible for mines to be equipped with delayed action fuses to provide sufficient time for foreign-flag ships to clear the port or for shipping en route to the port to be diverted.

daily number of ships at Haiphong during July-December 1966 included nine freighters (three Soviet, two Eastern European, two Free World, and two Chinese Communist) and one Soviet tanker. In addition, two to four ships (of the flags listed above) were loading at Cam Pha and Hon Gai on any given day.

The immediate effect of mining the ports would be an intensive disruption of normal transport activity. If the mining program were applied only to oceangoing shipping, the disruption would be severe because of the need to adopt alternative distribution procedures, to re-route import traffic, and to undertake a comprehensive reallocation of rolling stock, vehicles, and water craft and to reassign personnel.

The maximum impact of the program would be to delay but not deny the delivery of imports. North Vietnam has already demonstrated its ability to maintain petroleum imports at some 700 tons a day despite the severe disruption caused by the attacks on the petroleum storage and handling facilities at Haiphong. In addition to maintaining imports at least at essential levels, North Vietnam would also be able to maintain the flow of the export trade that would remain, particularly after attacks on modern industry.

A mining program including mines capable of stopping the movement of shallow-draft shipping and inland watercraft would, of course, bring about an almost complete cessation of waterborne foreign trade. The disruptive effect would then be compounded by the need to reallocate resources in order to maintain foreign trade exclusively on the rail and road connections to Communist China.

Under either mining program the amount of delay or denial of normal foreign trade movements would depend on the extent of North Vietnam's contingency planning. The organization of transport to cope with the effects of bombing has improved substantially in the past year. The extensive publicity given to possible US courses of action against the port of Haiphong makes it highly probable that plans to deal specifically with a mining of the port are well developed.

The principal means adopted to maintain foreign trade would involve, if possible, the use of shallow-draft watercraft to transport supplies from oceangoing ships to shore facilities. There are probably more than 900 motor-powered junks and about 4,800 sailing junks operating in the waters off southern China and the northern coast of North Vietnam that might be used to improvise lighterage in addition to the craft normally available for this purpose.

In addition to using this expedient to move traffic through the major ports of Haiphong, Cam Pha, and Hon Gai, the North Vietnamese would probably try to make increased use of the river port of Nam Dinh. The port area of Nam Dinh, including wharfs and riverbank suitable for handling cargo, has a cargo-discharge capacity of about 3,625 tons a day. Although access to these facilities would be restricted by draft limitations -- 9 feet -- the port and river facilities would be a valuable adjunct to emergency cargo-handling programs.

To the extent that coastal shipping and lightering could not be effectively used, particularly if the use of mines effective against shallow-draft craft denied all sea access to North Vietnam, the burden of maintaining foreign trade would fall on the land transport connections with Communist China. Land transport from the Chinese port of Fort Bayard or other Chinese ports via the Chinese rail network to the border at Dong Dang provides the North Vietnamese with a significant alternative route for their foreign trade if the ports are mined. This route probably could provide sufficient capacity for all of the normal imports of North Vietnam. If US airstrikes against the rail network continue at the level achieved in 1966, North Vietnam should have no difficulty in maintaining both the current volume of imports and exports moving by land and the imports normally received by sea.

The Hanoi - Lao Cai rail line, which could serve as another alternate route, was effectively disrupted for through service for about five months in 1965 and for at least as long in 1966. There are indications, however, that the North Vietnamese may have begun to ship apatite from Lao Cai through Yunnan Province to the rest of China over the new K'un-ming - Kuei-yang railroad, which was opened to traffic during the first part of 1966. Thus North Vietnam now has a second rail line to China which can be used for imports and exports.

As of 1 January 1967, North Vietnam had nearly 1,100 freight cars remaining in its freight car inventory, including an estimated 200 tank cars. Some meter-gauge freight cars, including about 150 tank cars, may also have been obtained from Communist China, and North Vietnam may now be using standard-gauge rolling stock from China. Thus it is estimated that sufficient equipment and excess capacity is available on the railroad lines to carry any tonnage that might be diverted to them by mining North Vietnam's ports and waterways.

Although road transport has not been used for a significant quantity of North Vietnamese foreign trade, it is available as an

alternative to sea or rail transport. The North Vietnamese have shown considerable ability to maintain motor transport operations in spite of the airstrikes delivered thus far. The approximately 11,500 trucks in the North Vietnamese civilian and military truck inventories would probably be sufficient to move over the roads such import and export tonnages as might not be handled by rail movement for various reasons.

A final alternative would be rail-water shipments using the new railroad within Communist China to Yunnan Province and thence via the Red River to Hanoi.

B. Measures to Reduce the Volume of Traffic

The semi-strategic attack discussed in Appendix B should eliminate most of North Vietnam's seaborne exports. Export of coal from Hon Gai and Cam Pha represents about 80 percent of the volume of North Vietnam's total seaborne exports in 1966. Coal exports normally account for about 25 percent of its foreign exchange earnings. Even if the export of coal were possible, the time and expense involved in its transportation by means other than water would probably make it an unprofitable trade. A similar situation would apply to the export of cement and apatite. In fact, the export of apatite had been reduced drastically by August 1965. If these exports had to be forgone, North Vietnam's seaborne exports would decline from about 4,800 tons per day, including coal, to less than 460 tons a day at the 1965 rate, and from about 3,200 tons per day to 300 tons a day at the rate of 1966.

North Vietnam would find it more difficult to cut back on its imports. Fertilizers, grains, and other bulk foodstuffs are important to the economy, and although the volumes could be reduced somewhat, the North Vietnamese would probably try to maintain them as long as possible. The need to import coal for the coking plant at Thai Nguyen -- an estimated 150,000 to 200,000 tons in 1966 -- would be eliminated if this plant were attacked.

With this exception it is estimated that as long as North Vietnam has the route capacity and necessary transport equipment it will seek to maintain both its normal imports and the added import burden caused by the attacks on its modern industrial system.

III. The Cumulative Effect on Imports of a Mining and Industrial Bombing Program

Imports by North Vietnam in 1966 amounted to about 1.5 million tons. In terms of daily traffic movement these imports were transported as follows:

	<u>Tons</u>
By sea	3,000
By rail	1,200
Total	<u>4,200</u>

In Appendix B it was estimated that the attacks on the modern industrial target system would increase annual import requirements by 500,000 tons, or 1,400 tons a day. On the assumption that North Vietnam would maintain both the normal and added import requirements, the total volume of imports would then amount to about 2 million tons.

Depending on the nature of the mining program, North Vietnam could use several alternatives to maintain the volume of imports. It has been estimated that if the mining program were confined exclusively to oceangoing shipping, North Vietnam could maintain seaborne imports at about one-half the 1966 level, or 1,500 tons a day. The import requirement to move only by land routes would then be about 4,100 tons a day. The following tabulation shows the daily capacity available to move these imports on the northeast or northwest land routes singly or in combination:

	<u>Tons per Day</u>		
	<u>Northeast Routes</u>	<u>Northwest Routes</u>	<u>Total ^{a/}</u>
Railroad	3,000	600 (3,000)	3,600 (6,000)
Road	2,000	1,200	3,200
Inland water		1,500	1,500
Total	<u>5,000</u>	<u>3,300</u> (5,700)	<u>8,300</u> (10,700)
Assumed imports	4,100	4,100	4,100
Deficit or surplus capacity	900	-800 (1,600)	4,200 (6,600)

a. Data in parentheses are based on the assumption that the railroad from Yunnan is restored to its original uninterdicted capacity.

The North Vietnamese would find it difficult if not impossible to maintain all imports by relying solely on the northeast or the northwest route, particularly under interdicted conditions. The combined capacity of both routes, however, is well in excess of requirements, even with the Hanoi - Lao Cai line measured in terms of its presently low, interdicted capacity.

If the mining program included the laying of mines capable of neutralizing both inland water and coastal craft, the entire import burden would then fall on the road and rail connections to Communist China.* The comparison of route capacity and imports would then be as follows:

	Tons per Day		
	<u>Northeast Routes</u>	<u>Northwest Routes</u>	<u>Total</u>
Railroad	600 (3,000)	3,000	3,600 (6,000)
Road	1,200	2,000	3,200
Total	<u>1,800</u> (4,200)	<u>5,000</u>	<u>6,800</u> (9,200)
Assumed imports	5,500	5,500	5,500
Deficit or surplus capacity	-3,700 (-1,300)	-500	1,300 (3,700)

In this situation, either import route alone would be inadequate to maintain import traffic. Imports could be maintained, however, by the combined use of both routes, although at considerable cost in time, money, and physical effort. All of the routes would also be operating at near capacity levels, particularly if a sustained interdiction and armed reconnaissance program is undertaken.

IV. Impact of Mining Under an Intensified Armed Reconnaissance

The effectiveness of a comprehensive mining program would be greatly enhanced by an expanded bombing program, including intensive interdiction of road and rail connections with China and 24-hour armed reconnaissance against all forms of transport -- particularly in the northern part of North Vietnam.**

* This appendix does not consider a third alternative in which the mining of inland waterways would not be a part of the mining program.

** See Appendix E.

The main rail connection to Communist China, the Hanoi-Dong Dang line, is currently operating at about 40 percent of its capacity to carry imports. The additional import requirements resulting from the mining program and the attack on industrial targets would raise traffic to a level considerably in excess of the uninterdicted capacity of the Dong Dang line. The North Vietnamese would then be forced to try to use the new Chinese railroad through Yunnan Province and thence the Hanoi-Lao Cai line as well as the highways and inland waterway. The rail distance to Hanoi from Fort Bayard via Lao Cai is over 2,000 kilometers, nearly three times the distance via Dong Dang, thus adding to the cost and effort. Nevertheless, the alternate railroad connection, in addition to the highways and inland waterways, would represent considerable additional transport capacity.

Interdiction of the lines would force the Communists to allocate considerable amounts of manpower and materials to maintain the railroad lines and alternative highway routes. The repair of major bridge structures would be measurably more complex and expensive than the relatively simple expedients which keep traffic moving in the southern provinces and in Laos. Sustained 24-hour attacks on locomotives and rolling stock by armed reconnaissance would stop all daylight traffic and disrupt nighttime traffic, thus slowing down movements and making the flow of traffic uneven. The North Vietnamese would probably be forced to make greater use of highway and inland water traffic. Although it is extremely difficult to interdict these systems, their greater use would increase the opportunities for harassment of actual traffic movement.

APPENDIX D

INTERDICTION OF THE LEVEES IN THE RED RIVER DELTAI. The Levee as a Target SystemA. Geographic Characteristics

The Red River Delta is a flat plain of about one million hectares* crisscrossed by natural rivers and manmade canals for irrigation and drainage. It constitutes the rice bowl of North Vietnam. From the head of the delta at Viet Tri, which is 100 miles inland, the average fall of the Red River to the Tonkin Gulf is less than six inches per mile, a factor which strongly influences its flood characteristics.

The rice fields and population centers of the delta are protected by an elaborate system of levees which have greatly reduced flooding from natural causes. Two rice crops a year are grown -- the fifth month rice is harvested in May-June and the tenth month rice in October-November. In pre-Communist times, heavy rains during July and August, when the river rises to a seasonal peak, frequently caused, through breaches in the levees, extensive floods and destruction to property and agricultural crops. No major breaches in the dikes have occurred since the mid-1940's; however, heavy rains continue to cause substantial losses to the rice crop. The Hanoi regime has moved about 1 million Vietnamese out of the delta over the past five years and has resettled them in highland tribal areas in an attempt to increase the food supply and reduce the pressure on the delta food base.

B. Vulnerability of the Levees and the Rice Crop

In order to inflict maximum damage to the rice crop -- the staple food in North Vietnam -- these levees would have to be breached at some time in the period mid-July to mid-August, when the Red River is at its height. During this period the level of the Red River is considerably above the level of the surrounding plain. At this time, the tenth month rice crop -- normally about two-thirds of the annual harvest -- is vulnerable to flooding and would be completely destroyed if the submersion of the rice plants persisted beyond two weeks. The rice plants are most vulnerable to shorter periods of submersion 10 to 20 days after transplanting, or around mid-August. Aerial reconnaissance and weather data could identify an optimum attack time.

* One hectare is equal to 2.471 acres.

The areas most vulnerable to flooding, if the primary levees of this system were breached, are the Ha Dong area southwest of the Red River and the Ha Bac area northeast of the river. A secondary system of levees in these areas has tended to confine the damage from major floods in the past to roughly 200,000 hectares. Breaching of the secondary levees could substantially increase the acreage flooded. If only the main levees were breached, it is estimated that the crop loss would be on the order of several hundred thousand tons of rice. If the secondary levees were also effectively breached, the decrease in rice production could reach a million tons.

The damage to agricultural crops in the Ha Dong area would be less than the damage to agriculture in the Ha Bac area. It is estimated that the tenth month rice culture, within the delta, beyond the left bank of the river (the Ha Bac area) occupies nearly 90 percent of the total area and that the rice fields beyond the right bank (the Ha Dong area) occupy only about 60 percent of the area. Estimates of rice losses as a result of flooding in these two areas are shown in Table D-1.

Successful breaching of these levees would also affect the one and one-half million people in this area, which includes the city of Hanoi. Furthermore, most of the industrial, commercial, and military activity in Hanoi and its suburbs would be temporarily halted until the water receded.

To mitigate the effects of the flooding, Hanoi would be forced to divert an undetermined but very sizable work force away from other activities, including those of a military-supporting nature, for a period of weeks until the major damage had been repaired.

JCS targets which would be vulnerable to inundation are as follows:

<u>JCS Target Number</u>	<u>BE Number</u>	<u>Installation</u>
		Hanoi/Gia Lam Airfield
		Hanoi/Bac Mai Airfield
		Hanoi Railroad Yard
		Ha Dong Army Bks and Supply Depot
		Hanoi POL Storage Thanh Am
		Hanoi POL Storage Bac Mai

25X1

JCS Target Number	BE Number	Installation
		Hanoi MND/Army & MZ Hqs/Bks & Supply Depot
		Hanoi Army Bks S Quinh Loi
		Hanoi Army Supply Depot N Tay Ho
		Van Dien Army Supply Depot
		Hanoi International Radio Transmitting Station, Dai Mo
		Hanoi Port Facilities
		Hanoi Engineering and Machine Tool Plant
		Hanoi Thermal Powerplant

In addition, there are additional war-supporting military barracks, storage areas, and communications facilities which would be affected by the flooding.

II Dimensions of the Air Attack

A. Over-Target Weapon Requirements

Target studies have identified the Ha Dong and the Ha Bac areas southwest and northeast of the Red River, respectively, in the vicinity of Hanoi as the most promising for attack, since they have been particularly vulnerable to flooding in the past. The areas are traversed by Route 1A, the main road from Hanoi southward along the coast; the Hanoi-Thanh Hoa rail line; and Route 6 which leads to the Dien Bien Phu area. These transportation routes are on embankments.

The bombing objective would be to create a series of levee cuts. Since the thickness of levee crown is approximately 80 feet when the Red River is at the 33-foot stage, a series of overlapping craters across the entire levee crown would be necessary to create a breach. A single hit by a 1,000-or 2,000-pound bomb would not be sufficient to create a breach and generate the necessary scouring action of water rushing through to widen and deepen the break. The most economical means of creating the series of overlapping craters is with eleven-bomb trains of 1,000-pound general-purpose bombs, which penetrate about 10 feet in average soil and produce craters about 37 feet in diameter. (An intervalometer setting of 30 feet has been assumed.) The following tabulation shows three assurance levels of cutting the levee when the river is at the 33-foot level:

Table D1

Estimated Loss in Production of 10th Month Rice Crop
in North Vietnam Caused by Flooding a/

Area Beyond Right Bank (Southwest) of Red River				Area Beyond Left Bank (Northeast) of Red River ^{25X1}			
Area Flooded (Thousand Hectares)	Area in Fall Rice Affected (Thousand Hectares)	Estimated Loss (Thousand Tons)	Percent of Annual Harvest of Rice	Area Flooded (Thousand Hectares)	Area in Fall Rice Affected (Thousand Hectares)	Estimated Loss (Thousand Tons)	Percent of Annual Harvest of Rice
50	30	60	1	50	45	90	2
100	60	120	3	100	90	180	4
150	90	180	4	150	135	270	6
200	120	240	5	200	180	360	8
250	150	300	7	250	225	450	10
300	180	360	8	300	270	540	12
				350	315	630	14
				400	360	720	16
				450	405	810	18
				500	450	900	20

a. Based on the assumption of submersion of rice plants for a minimum of two weeks.

<u>Percent Assurance</u>	<u>Number of Trains</u>	<u>Number of 1,000-Pound General-Purpose Bombs</u>	<u>Tons</u>
50	5	55	27.5
70	6	66	33.0
85	8	88	44.0

These assurance levels apply only to one breach; from two to four separate and almost simultaneous breaches are probably required to achieve the type and extent of flood damage discussed above. Additional strikes would be necessary to breach the secondary levee system.

If the bombs were not dropped in trains but were individually aimed, over-target tonnage requirements would be substantially higher than those in the tabulation above.

B. Effects of Attack

A successful attack on the levee system at Ha Dong would be exceedingly disruptive in the short run. There are probably 1.5 million people in the Ha Dong area, including Hanoi. This Agency has not made an independent study of the probable level of casualties; military target studies estimate that they would be small, numbering in the hundreds rather than thousands. Homes in the village areas would be destroyed, factory activity would be halted, and the flood would be exceedingly disruptive in the short run to the social order in the affected areas. Over the long run the effect on rice availabilities would probably be the hardest problem for the regime. The loss of at least several hundred thousand tons, and perhaps 1 million tons, of rice, particularly in a year of below-average harvests, would force Hanoi to seek outside sources of supply. Communist China, which in an average year produces 75 million to 85 million tons of rice, could provide the necessary amount. Under conditions of continuing air interdiction of the land links between North Vietnam and Communist China, transport of such supplies could be difficult. Also, China would be forced to purchase offsetting quantities of grain in Free World markets because its food supply is not adequate to cover fully its domestic requirements.

Apart from the short-term disruption of military supplies moving to South Vietnam, there would be few other military effects. Any food deficit in North Vietnam which could not be made up by imports would fall on the peasantry and not on the military or government forces.

Since the major burden of a successful levee attack would fall on the civilians in agricultural areas, there probably would be a highly adverse public reaction in the West. This criticism would be more strident than that which would be expected from attacks on any other target system, with the possible exception of raids on population per se. Since the military effects of "levee busting" would be both limited and short lived, the effect on the Hanoi regime's will to persist would be marginal. Indeed, Hanoi would be presented with a propaganda theme which would win it widespread sympathy and support in the West.

C. Countermeasures

The North Vietnamese are well aware of the importance of the levee system, and the regime has maintained and strengthened the system over the years. The existence of a secondary system of levees, which also would require breaching to maximize effectiveness, tends to limit the effects of breaching the primary system. Well before the initiation of US air attacks in 1965, discussions within the North Vietnamese regime of the importance of the levee system highlighted the success of the Viet Minh in countering the effects of French destruction of levees and dams and suggests that past experience has in part prepared the regime for such eventuality. One method of countering the effects of a breach in the levees in the target area is to deliberately breach a number of the levees upstream and divert the water into less important agricultural areas. Defensive breaching of this type could rapidly drop the level of flood water at Hanoi by as much as six feet. A specific illustration of the sensitivity of the North Vietnamese regime to possible attacks on levees was contained in a recent report which mentioned the collection of materials in the Hanoi area to fill breaches in the levees. However, these countermeasures would probably be ineffective if an attack of adequate size were carried out quickly and successfully.

D. The Effect on Imports

Depending on the extent of the flooding, crop losses in the Red River Delta would probably range between 250,000 and 1 million tons. In view of the tight food situation in North Vietnam at present, it is believed that it would be necessary to replace the entire loss with imports in order to avoid severe food shortages or to adopt more rigorous rationing programs. In terms of refined rice (using a milling ratio of about 70 percent) this loss would amount to about 175,000 to 700,000 tons. Presumably, importation of this requirement could be spread over about nine months because the amount destroyed would consist of not more than one-fourth of the annual crop, or three months' supply.

The importation of an additional 175,000 to 700,000 tons, or 640 to 2,500 tons a day, during nine months would present problems of varying severity, depending on many factors such as whether there were damage to the railroad and road network by the flooding, the nature of the mining programs, and the intensity of the armed reconnaissance and interdiction campaigns against the logistic target system.

The breaching of the levees is assumed to follow the attacks on modern industry discussed in Appendix B and the execution of the mining program discussed in Appendix C. If the North Vietnamese were to attempt to maintain the normal flow of imports plus the import requirements generated by the attacks on industry and the levee system, the cumulative import requirement would be between 2.2 million and 2.7 million tons. About 2 million tons of these imports could be moved throughout the entire year, at an average daily rate of 5,500 tons a day. The rice movement, however, is assumed to be accomplished within a nine-month period at a daily rate of from 640 to 2,500 tons a day. Thus the North Vietnamese during most of the year would have to maintain a maximum import movement of 8,000 tons a day.

The ability to move this amount of cargo on a sustained daily basis will depend in part on the nature of the mining program and on the intensity of armed reconnaissance and air interdiction programs.

If the mining program adopted is the one directed solely against oceangoing shipping, the North Vietnamese would be able to import an estimated 1,500 tons a day by use of shallow-draft coastal shipping and lighters. They would, moreover, have access to the inland water approaches to North Vietnam. In this situation there would be from 8,300 to 10,700 tons of route capacity available on a daily basis to accommodate the movement of 6,500 tons of import cargo.* With this amount of capacity available the North Vietnamese would be able to move all of the import requirements, provided that the major routes were not heavily interdicted. An intensive interdiction program would, however, make the flow of imports considerably more uncertain and costly.

* The lower limit of the range includes the Hanoi - Lao Cai rail line at its present interdicted capacity of 600 tons a day. The upper limit assumes that the line is maintained at essentially its uninterdicted capacity.

If the mining program were directed at shallow-draft craft and the inland waterways system, however, water access to North Vietnam would be cut off. In this case the North Vietnamese would have route capacity ranging from only 6,800 to 9,200 tons a day to handle daily imports of 8,000 tons. If the levee program achieved its estimated maximum effect, the North Vietnamese import capability would then fall short of requirements by about 15 percent. Total imports could be maintained only by restoring the Hanoi - Lao Cai line to its uninterdicted status.

The nature of the terrain and the more complex bridges found in the northeast and northwest transport connections to China make them much more vulnerable to interdiction programs. For example, if an interdiction campaign reduced the capacity of the rail lines on a sustained basis by only one-third and of the road systems by only one-fourth, the available route capacity would then be only 6,400 tons a day. The North Vietnamese would then be hard pressed to move even their minimum import requirements, and if the interdiction program were even more successful, as an all-out attack should be, the regime would face increasingly severe problems. Hard decisions would have to be made about the imports which could be forgone, and a system of more rigorous rationing would probably become necessary. More importantly, the continuity and reliability of the flow of essential military and economic assistance from the USSR and Communist China would become a matter of highest concern.

APPENDIX E

UNLIMITED BOMBINGI. Transportation Targets

An unlimited campaign against transportation targets, particularly those in the northern area, holds promise of significant results. Although the transportation system has been a major target since the inception of the Rolling Thunder program, the weight of the bombing effort has fallen on Route Packages 1, 2, and 3, where military and economic requirements for traffic movement have been relatively small in relation to route capacity. Hence, despite the weight of attack, the North Vietnamese have been able to keep essential supplies flowing.

The basic concept of an unlimited attack on transportation would be to take advantage of the two major factors which emerge from the bombing campaigns outlined in earlier appendixes. These are (1) the emergence of a higher import requirement as the result of the neutralization of most production facilities and (2) the anticipated closure, or near closure, of North Vietnamese ports and the inland waterway system by mining. Under these circumstances, we estimate a daily import requirement of between 6,100 tons and 8,000 tons, depending on the extent to which the food supply is impaired through an attack on dykes or as a byproduct to attacks on other target systems in the north. Under these circumstances, the remaining rail and road connections to Communist China would be forced to operate at -- or virtually at -- capacity. Should these circumstances prevail, disruptions to main rail and road arteries created by airstrikes would then begin to bite into the movement of traffic and to force Hanoi to make meaningful decisions on the pattern of imports, with consequent effects on the economic and possibly the military establishment.

The capacity of the two railroad lines connecting Communist China with North Vietnam is currently estimated at 3,600 tons per day. The average capacity would increase to 6,000 tons per day if the bridge at Viet Tri is restored or if ferrying arrangements are made to effectively transfer this capacity to other means. In any event, there would be a delay of at least two months to restore this capacity.

The daily capacity of the five roads leading into North Vietnam from China is very tentatively estimated at 3,200 tons. There is a fairly wide

margin of error associated with this estimate. To effectively utilize these roads, several thousand motor trucks would be needed for the movement. Given the sponginess of the data, we cannot be too precise about the ratio of capacity to import requirements. However, the following two conclusions seem warranted:

(a) That the uninterdicted capacity of the roads and the rail lines, allowing sufficient time to organize the necessary truck transport, would probably be sufficient to transport the required daily tonnages in full to North Vietnam, even if the ports were mined.

(b) That given a successful interdiction campaign, the net capacity of the roads and the rail lines would be insufficient to satisfy the maximum daily requirement, and therefore some reduction in the desired levels of supplies would take place.

In an unlimited target program the aim would be to neutralize as much railroad and road capacity as possible and to saturate the enemy's capability to repair or to improvise alternates to restore it. There are nine JCS bridge targets on the two railroad lines connecting Hanoi with the border of China, four of which have been struck and restored, and one of which has been struck and not restored. In addition to these bridge targets, there are 132 bridges on the railroad lines not on the JCS target list. On the major road routes leading from Hanoi to China, there are 13 JCS bridge targets and over 500 bridges not on the JCS target list. For the most part, these bridges are not located in populated areas, although several bridges are not recommended as targets because of the potentially high incidence of civilian casualties. In addition to the bridges, targets of opportunity will become apparent such as trains and trucks moving through the open country, concentrations of railroad equipment, and trucks.

The target value of the major railroad yards and shops on the JCS Target List is discussed later in this appendix.

The effect of a successful unlimited program against transport as discussed herein would be that the North Vietnamese would be hard-pressed to maintain the movement of their import requirements. If the interdiction program were highly successful, the regime would encounter increasing difficulty and cost in maintaining the flow of some of their most essential military and economic goods. This could force Hanoi to make difficult decisions about the imports to be forgone and to adopt more rigorous systems of rationing. In the long term the uncertainties and difficulties resulting from the cumulative effect of the air campaigns would probably cause Hanoi to undertake a basic reassessment of the probable course of the war and the extent of Hanoi's commitment to it. A recapitulation of the principal fixed targets in this program is given in Table E1.

II. Other Potential Targets

A. Military

In addition to industrial-economic targets, there are a number of military facilities presently on the JCS target list whose neutralization would be of importance in blunting the military capabilities of North Vietnam. The most prominent of these are 11 airfields. There are also a number of barracks and smaller military supply depots widely dispersed throughout North Vietnam. In an unlimited campaign these facilities presumably would be taken under attack.

B. Primary Telecommunications Targets

There are four installations within the telecommunications system which are of primary importance. The four are radio communications centers located, respectively, near Phu Coc, Dai Mo, Son Dong, and Me Tri. The first three are on the JCS Target List but have never been struck; the fourth has not previously been targeted. Each is situated at least a half mile away from civil population centers.

Neutralization of these radio centers could produce the following effects: (1) a temporary disruption of top-priority command and control channels used by Armed Forces High Command in Hanoi; (2) a similar temporary disruption of international telephone and telegraph service; (3) enforced use of less efficient transmission media; and (4) severe curtailment, if not cessation, of operations by North Vietnam's primary propaganda broadcast facility.

Table E1

Principal Fixed Targets in an Unlimited Target
Program Against Transport in North Vietnam

1. Targets to Halt Movements by WaterJCS No.

None

None

- a. Haiphong mineable area
Gulf of Tonkin
- b. Cam Pha approaches mineable area
- c. Hon Gai approaches mineable area
- d. Channels in the Red River Delta
mineable area
- e. Upper reaches of the Red River
in North Vietnam mineable area

25X5

2. Targets to Halt Movements by LandJCS No.

Various and
armed reconnaissance

- a. Continuation of present program in
Route Packages 1, 2, 3
- b. Targets north of Hanoi
 - 1. Railroad targets



- (a) Hanoi railroad and highway
bridge over Red River
- (b) Hanoi railroad and highway bridge
over Canal des Rapides a/
- (c) Viet Tri railroad and highway bridge
over Riviere Claire
- (d) Dap Cau railroad and highway bridge
over Song Cau
- (e) Lang Son railroad and highway
bridge over Song Ky Cung a/

25X5

a. High level of potential civilian casualties precludes recommendation of
this target.

2. Targets to Halt Movements by Land - continuedJCS No.

None

(f) Bac Giang railroad and highway bridge over Song Thuong

25X5

(g) Cao Nung railroad bridge over Song Hoa

(h) Lang Dang railroad bridge over Song Thuong

(i) Vu Chua railroad bridge over Suoi Ngang

(k) 132 additional bridge targets

3. Highway TargetsJCS No.

None

a. Kep highway bridge over Song Thuong

25X5

b. Thai Nguyen highway bridge over Song Cau

c. Cho Moi highway bridge over Song Cho

d. Ha Gia highway bridge over Song Cong

e. Long Khap highway bridge over Song Chay

f. Bac Can highway bridge over Song Cau

g. Lang Luong highway bridge over Song Mo Ga

h. Vinh Tuy highway bridge over Song Con

i. On highway bridge over Song Thuong

j. Me Xa highway bridge over Song Ky

k. Chieng Chang highway bridge over Song Luc Nam

l. Lang Met highway bridge over Song Thuong

m. Lam highway bridge NE over Song Luc Nam Tributary

n. Over 500 additional bridge targets

Whether concentrated on these four targets or substantially amplified, Rolling Thunder attacks are unlikely to produce more than temporary and/or localized disruptions of communications regarded by Hanoi as critical. In addition to its major fixed installations, North Vietnam has available several hundred small radio stations, almost all of which are readily transportable and easily concealed from detection by air. These -- together with an extensive wireline system which could not be seriously interdicted at practicable cost -- provide North Vietnam with a virtually irreducible base of telecommunications. The availability of these alternate facilities almost certainly assures that, except for transient disruptions, the flow of essential military, economic, and administrative communications will be sustained.

C. Pharmaceutical Plants

Output from North Vietnam's pharmaceutical industry stems primarily from six plants, all of which are located in the Hanoi area, and one of which is on the JCS target list at present. These plants are: Pharmaceutical Products Plants No. 1 and 2, the Central Anti-Tuberculosis Institute, the Hygiene and Epidemiology Institute, and the Central Pharmaceutical Works, and the Veterinary Drug Factory. Pharmaceutical Products Plant No. 2, the country's most modern facility, was constructed with Soviet aid in 1958-60. Antibiotics reportedly are produced at this plant and at Pharmaceutical Products Plant No. 1, although fermentation capacities of both probably are small. The Veterinary Drug Factory, built with Communist Chinese aid in 1963, produces hog cholera vaccine and other pharmaceuticals for animal use.

Production by North Vietnam's pharmaceutical industry consists largely of repackaging and processing bulk pharmaceuticals imported from other Communist countries and from the Free World. Total pharmaceutical output for any time period is unknown, but is believed to be inadequate for basic peacetime needs.

Bombing of the pharmaceutical plants in Hanoi would have a small impact on North Vietnam's overall supply problem and could result in significant civilian casualties.

D. Transport Repair Facilities

Almost all of North Vietnam's capacity for the repair of railroad stock and equipment is accounted for by the Hanoi Railroad Car Repair Shops Gia Lam, the shops at the Hanoi Railroad Station and

Classification Yard, and the Haiphong Railroad Car Repair Shops. The first two facilities are on the JCS target list, the third is not. Most major repairs and overhauls are accounted for at this site, and the only three locomotives known to have been produced in North Vietnam were manufactured there. Despite some earlier bomb damage the great part of this capacity is still intact. About 3,000 civilians are estimated to be employed or living in the area in and around the shops, which are located near a village northeast of Hanoi.

The shops at the Hanoi Railroad Station and Classification Yard are the most important facilities for the repair of locomotives in the country. Located in the heart of Hanoi, the facility includes two large locomotive repair shops, one railroad car repair shop, and one turntable. The Haiphong Railroad Repair Shops are also in the center of Haiphong and consist of two large shops, with an estimated replacement cost of some \$2 million.

The extended loss of the locomotive and rolling stock repair shops would be a serious setback to North Vietnam and require an increased rate of imports of transportation equipment to compensate for a reduced repair capability. China could supply North Vietnam about 1,000 meter-gauge freight cars, 150 of which are tank cars, and about 100 to 120 meter-gauge locomotives, which have become surplus to China's needs by virtue of conversion of some internal rail lines to standard gauge. This quantity of transportation equipment is roughly equal to the size of the rail park being operated in North Vietnam at present. The transfer of such rolling stock to North Vietnam would neutralize for a period of from six months to a year most of the effects expected from successful attacks on the North Vietnamese transport repair facilities.

E. Textile Plants

Increased US/GVN bombing of the major textile plants will decrease the output of the plants and may cause an initial decline in the standard of living of the North Vietnamese population. The major textile plants in North Vietnam are the 8 March Textile Plant in Hanoi; the Dong Xuan Weaving Factory in Hanoi; the ready-to-wear clothing factory near Hanoi; and the Nam Dinh Textile Combine, which probably has been dispersed after the bombing of July 1965. The 8 March Textile Plant, the most modern of the textile installations, can produce between 35 million and 45 million meters of cotton cloth annually, along with 80,000 meters of other cloth. It can also produce about 5 million jute bags. With its labor force of 7,000 workers (70 percent of which are women)

it is one of the largest industrial installations in North Vietnam. It has been operating on three shifts during both 1965 and 1966. Reports have been received that at least part of the plant has been dispersed and that transportation and distribution difficulties have arisen as a result of the partial dispersal.

The Dong Xuan Weaving Factory, which is primarily a knitting mill, is much smaller than the 8 March Plant. In 1966 the factory has been trying to cope with producing under war-time conditions. It has been trying to repair its own machinery and to manufacture some of the spare parts for the knitting machinery.

F. Food-Processing Plants

Bombing of the food-processing plants in North Vietnam may initially cause a decline in the standard of living and will almost certainly end North Vietnamese exports to the Free World and to Eastern Europe. In 1965 North Vietnam exported about 30 percent of its total production of foodstuffs; these exports probably declined in 1966. North Vietnam has at least four major canneries, numerous sugar mills, and about 14 major rice mills -- gifts of Communist China. The canneries are located in Hanoi, Haiphong, Son Tay, and Phu Tho. Bombing of these canneries will reduce the supply of canned fish, meat, and fruit. The sugar mills can be classified as local industry and are located in most provinces.

The rice mills are located in Hanoi, Bac Giang, Viet Tri, Haiphong, Hai Duong, Hung Yen, Dap Can, Nam Dinh, Thai Binh, Ninh Binh, Ham Rong, Vinh, Ninh Giang, and Thanh Hoa. They have a total milling capacity of between 15 and 20 percent of the average annual rice production. It is not known whether the small cottage-type mills in the provinces and districts have sufficient capacity to fill the gap that would be created by the destruction of the major mills.

More primitive means of processing foodstuffs could be resorted to if the major commercial facilities were denied. Apart from the likelihood of greater spoilage and hence some decrease in domestic availabilities, we are unable to specify the effects of successful attack on the food-processing sector.

G. Fertilizer Plants

There are two fertilizer plants, the Lam Thao Superphosphate Plant and the Van Dien Phosphate Fertilizer Plant, which, while not connected with the explosives industry, are important in providing

chemical fertilizer for North Vietnamese agriculture. The Lam Thao Plant, built with Soviet aid, is North Vietnam's largest producer of fertilizer. Neutralization of this plant, representing about 56 percent of the national capacity, would undoubtedly result in some loss of rice production unless Hanoi were able to increase imports. About 150,000 tons of imports would be needed. The Van Dien plant has an annual capacity of about 20,000 tons and accounts for about 7 percent of the national capacity to produce chemical fertilizer.

APPENDIX F

THE LOGISTIC FUNNEL AS A TARGET SYSTEMI. Conclusions

Over 60 percent of all airstrikes in North Vietnam and Laos during 1966 were carried out against targets in the "logistic funnel," which comprises Route Packages 1 and 2 in North Vietnam and the road network through the Laotian Panhandle (see the map Figure F1). The total effort in these three areas during the first 11 months of 1966 amounted to about 68,000 attack sorties delivering about 112,000 tons of ordnance to the target area. Despite this effort, the flow of supplies currently needed from North Vietnam to support the VC/NVA forces fighting in the south has continued. The physical damage caused by the present bombing program in the "funnel" has been offset by the determined effort of the Communists to keep the routes open. Their willingness and ability to resort to primitive methods of crossing streams and transporting supplies has been a major factor accounting for continued logistic movement.

Concentration of all Rolling Thunder attack forces on the "logistic funnel" would increase by about 60 percent the weight of the bombing program in this area, raising the level of ordnance expended from 10,000 tons to around 16,000 tons per month. In a short time the North Vietnamese would respond to the intensified bombing by increasing the size of the labor force engaged in repair work. The required 30 percent increase in manpower could be drawn from areas of North Vietnam no longer being bombed, and would be made up of experienced repair crews. Moreover, the air defenses in the "funnel" also would be strengthened to aid in countering the intensified bombing program. Hence, it is believed that the logistic support to the VC/NVA forces would be continued. Unless the Communist order of battle in South Vietnam were substantially increased over current levels, supplies should continue to be available.

A similar program to reduce the logistic capacity of the Communist Chinese and North Korean forces, called Operation Strangle, was carried out during the Korean War with only limited effectiveness. A strip across North Korea, 60 nautical miles in depth, was bombed day and night for 11 months in an attempt to cut off supplies needed by the Communist armies. By means of a system of countermeasures very

similar in scope to those now being carried out by the North Vietnamese, the Communists greatly reduced the effectiveness of the US bombing program while at the same time continuing to provide the necessary supplies for their war effort. Operation Strangle is generally credited with holding down the flow of supplies so that Communist offensive actions were limited, but defensive actions were virtually unimpaired. In any event, Communist logistic requirements in Korea were of a completely different order of magnitude -- a few thousand tons a day were needed by Communist armies.

II. Background

The "logistic funnel" consists of transportation Route Packages 1 and 2 in North Vietnam and the connecting road network in the Laos Panhandle. In North Vietnam, this includes all transportation routes south of Vinh to the Demilitarized Zone. In Laos the road network extends south from the Mu Gia Pass area to the end of Route 96 opposite Kontum Province, South Vietnam. The logistic capacities of the major routes in the "funnel" are contained in Table F1. These theoretical pre-strike capacities range from 92 tons per day in the southern Laotian Panhandle to 1,025 tons per day in the Vinh area of North Vietnam. Because of the primitive level of economic development in the area, the use of these major routes either for economic purposes or as supply channels to support the Communist war effort has never placed a strain on the nominal capacities of these routes. It is probable that, given the extensive system of countermeasures developed by the Communists in the "logistic funnel", their capacities have not been reduced by more than 20 percent. A more intensive bombing program could reduce the capacities of these routes to less than 50 percent, which would still be well above the relatively low logistic support requirements. During the rainy season the problems of transportation are multiplied as are the problems of bombing the supply lines. Washouts and mud make overland movement difficult and uncertain. At the same time, high water makes many more streams navigable and vastly increases their total length of navigability. The rainy season also provides large amounts of cloud cover which affords an additional amount of protection for Communist logistics operations. Since the logistics net in the "funnel" is composed of both land and water routes, and tonnage requirements are so small when compared with total capacity, the rainy season does not present a serious problem to the Communists at this time.

During 1966, over 60 percent of all airstrikes against North Vietnam and Laos were concentrated on "logistic funnel" transportation targets -- bridges, rolling stock, trucks, watercraft, supply dumps,

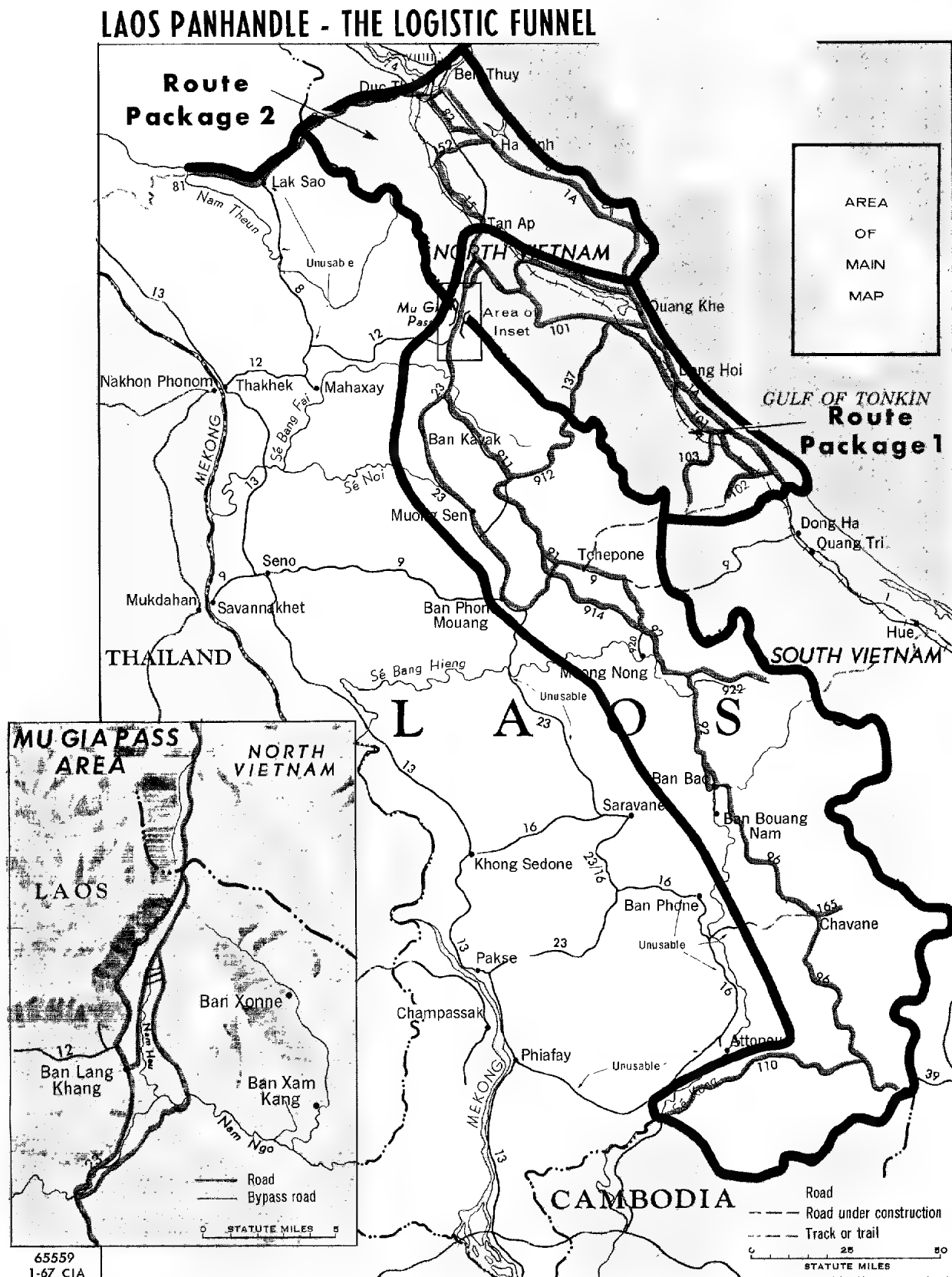


Figure F-1. The Laos Panhandle: "The Logistic Funnel"

and other related targets. In 1966 the average monthly ordnance dropped on the funnel targets amounted to over 10,000 tons (see Table F2). As can be seen from the increased rate of infiltration of North Vietnamese troops to South Vietnam and the countering of bomb damage to routes in the funnel, however, the present level of bombing has had little adverse effect on Communist ability to support the war in South Vietnam.

Concentrating all ordnance tonnage on the "logistic funnel" target, instead of the present share of 60 percent, would permit delivery of over 16,000 tons per month on "funnel" targets.

III. Estimated Effects on the Flow of Supplies to South Vietnam

In 1966, more than 250 bridges in the funnel area were confirmed by aerial photography to be damaged or destroyed. Most identified fixed targets were struck more than once. Despite the intensive bombing, the supply lines from North Vietnam to the VC/NVA forces fighting in the south have been kept open. To accomplish this feat, the principal input has been labor, with about 40,000 workers engaged in full-time repair activity along Route Packages 1 and 2 and with another 25,000 repairing roads in the Laos Panhandle. Hundreds of work teams have been organized and stationed at chokepoints, together with the necessary materials, to repair bridges and cratered roads.

Speed and simplicity of repair have been the hallmark of the program. Hand tools and local building materials (mainly timber and stone) are used, for the most part, to carry out repairs and construction work. Destroyed bridges have been replaced by multiple stream crossings such as bypass bridges, fords, ferries, and culverts. Alternate routes have been built. A new bridging technique has been developed using steel cables and removable bridge decking to reduce the vulnerability of bridges to air attack. Camouflaged bridges and alternate dummy bridges with rope and netting have been constructed to deceive pilots. In heavily forested areas, repair work has been carried out during daylight hours under a canopy of natural foliage, but a great deal of work also has been undertaken at night to protect workers from attack.

The work units in North Vietnam have now developed a high degree of skill in making quick repairs and constructing bypasses. If the bombing were shifted entirely to the funnel area, additional manpower would be needed to maintain the lines of communication to South Vietnam. It is estimated that 20,000 more workers, about a 30 percent

increase over the present work force, would be required. However, a sudden shift in the bombing pattern would not, in all probability, be responded to immediately by the North Vietnamese. It would take time to shift experienced repair crews to the south and to arrange for the additional flow of repair supplies to the area. Temporarily, the flow of supplies to South Vietnam could be impeded while countermeasures were being organized -- probably a period of several weeks.

It is expected that the North Vietnamese would respond by making greater use of camouflage, pontoon bridges, and other bridging techniques which would allow removal of bridge deck sections during daylight to simulate unserviceable bridges. Besides increasing their effort to repair the existing routes and more intensively using foot trails, the North Vietnamese would probably construct new north-to-south roads through the highlands of southern North Vietnam and in Laos. There are probably greater opportunities for cave storage. It is probable that many more antiaircraft artillery and SAM sites would be deployed in the target area within two to three weeks after the Hanoi regime realized that the United States had changed its bombing strategy. For example, a SAM site was established within target range of Mu Gia Pass within two weeks after the first bombing raid by B-52's in April 1966.

Finally, shifting the bombing entirely to the southern part of North Vietnam and Laos would provide a boost to the morale of the North Vietnamese. The main industrial, agricultural, and administrative centers are in the north. Most of the population, therefore, would be freed from problems engendered by air attack. The Hanoi regime would believe that its constant and strident propaganda to end the bombing had succeeded in large measure. Military and war-supporting civilian goods would again be moving unimpaired from the USSR and China into North Vietnam over the connecting rail lines and through the port of Haiphong. Hanoi could be expected to continue pressure to "end the bombing."

IV. The Experience of Korea

To strike the "end of the funnel" would be similar in objective to the famous Operation Strangle of the Korean War. Operation Strangle lasted 11 months and was a continuing day and night bombing attack of a strip 60 nautical miles deep across the entire Korean Peninsula. It was a comprehensive effort within a limited area to interdict North Korea's railroads and highways, thus impeding the flow of materials

to such a degree that the Communists would "not be capable of opposing the US Eighth Army effectively." Operation Strangle was terminated when it became evident that the Communists still were able to supply their frontline units by employing the same type of countermeasures the North Vietnamese are presently using. Operation Strangle is usually credited with holding down the flow of supplies so that Communist offensive operations were limited, but defensive actions were virtually unimpaired. In any event, the logistic requirements of the Communist forces in Korea were of a completely different order of magnitude -- a few thousand tons a day were needed by the Communist armies.

Given the present rate and scale of the conflict being carried out by the North Vietnamese and Viet Cong units in South Vietnam, a "Strangle" program in the "funnel" would probably be less effective than it was in North Korea. The total daily tonnages of material needed by the Viet Cong and the North Vietnamese regulars from North Vietnam is very small compared to the estimated 3,000 tons per day supplied to the North Korean and Chinese units during Operation Strangle. Moreover, the North Vietnamese have a more flexible area of operation than the North Koreans because they are not effectively blockaded by the US Navy on both sides of a peninsula.

Table F1

Logistic Capacities of Major Routes
in Route Packages 1 and 2, North Vietnam,
and the Ho Chi Minh Trail, Laos
1966

<u>Major Routes</u>		<u>Unattacked Capacity (Tons per Day)</u>	
<u>Location</u>	<u>Route Number</u>	<u>Dry Season</u>	<u>Wet Season</u>
North Vietnam			
Route Package 2	1A	861	108
	15	459	92
	8	459	92
	82	1,025	205
	152	803	161
Route Package 1	1A	861	108
	101	612	122
	137	459	100
	102	92	0
	103	92	0
Laos			
Mu Gia Pass to the tri-border area	12	367	0
	23	510	102
	911	408	0
	912	459	100
	91	306	41
	9	490	0
	914	204	41
	92	153	31
	96	92	0
	110	112	0

Table F2

Targets Destroyed or Damaged by Attack Sorties
Route Packages 1 and 2, North Vietnam
and Ho Chi Minh Trail, Laos a/
1966

Type	North Vietnam			Total for Route Packages 1 and 2 and Laos
	Route Package 2	Route Package 1	Laos	
Total all targets	<u>6,692</u>	<u>11,457</u>	<u>11,104</u>	<u>29,253</u>
Total moving targets	<u>2,651</u>	<u>3,090</u>	<u>2,074</u>	<u>7,815</u>
Motor vehicles	802	1,686	1,982	
Watercraft	1,696	1,355	91	
Railroad rolling stock	153	49	1	
Total fixed targets	<u>4,041</u>	<u>8,367</u>	<u>9,030</u>	<u>21,438</u>
Weapons	174	596	354	
Bridges/tunnels	941	1,030	856	
Road cuts	1,659	2,610	2,476	
Buildings	718	1,980	3,182	
Other <u>b/</u>	549	2,151	2,162	
Number of attack sorties	11,707	27,204	28,634	67,545
Ordnance expended (tons)	16,794	49,793	45,035	111,622

a. Information based on data through November 1966 obtained from OASD/Systems Analysis.

b. Including ammunition and supply, railroad track, and other non-personnel targets.

APPENDIX G

THE ESTIMATED CASUALTIES
RESULTING FROM ALTERNATIVE BOMBING PROGRAMSI. General

In this appendix the air campaigns analyzed in this memorandum are examined to obtain a rough order of magnitude of the probable level of casualties.

On balance, the campaigns being considered would tend to yield casualties at a significantly higher rate than that observed in 1965 and 1966. This higher level arises principally because the new campaigns tend to be centered on fixed targets located in the more heavily populated areas of North Vietnam. Specific numbers of casualties could not be estimated for every aspect of each campaign. A rough approximation indicates, however, that total casualties resulting from attacks on fixed targets alone could range from 15,000 to 20,000. Approximately one-third of these would be civilian casualties, most of whom would have been engaged in war-related activities. Casualties in this amount -- if they were all sustained in 1967 -- would be at a level from two to three times higher than that resulting from attacks on fixed targets in 1965 and 1966 combined.

II. Attack on Modern Industry

The majority of the remaining unstruck modern industrial facilities are located within the greater Hanoi-Haiphong area. Most of the remaining economic facilities in North Vietnam are located in Route Package 6 and many of them are within the greater Hanoi-Haiphong area. A total attack against these facilities would result in a higher rate of civilian and military casualties than that observed in 1965 and 1966 (see Table G1).

A. Powerplants

The seven powerplants on the modern industry target list are located in Route Package 6 and are generally close to the heavily populated Hanoi-Haiphong area. It is estimated that 8,500 people

Table G1

Potential Casualties Resulting from an Attack
on Selected Modern Industrial Targets a/

	<u>Civilian</u>	<u>Military</u>
Powerplants	300 to 500	20 to 70
Manufacturing plants	900 to 1,300	0
Total	<u>1,200 to 1,800</u>	<u>20 to 70</u>

a. Assuming a 70 percent damage level.

(7,000 civilians and 1,500 military) will be exposed to accurate bombing if all of the powerplants are attacked. Cumulative casualties are estimated to include 300 to 500 civilians and 20 to 70 military personnel if a total attack is launched.

25X5

25X5

Strikes against the Hanoi [redacted], Haiphong East [redacted], and Bac Giang [redacted] powerplants would probably cause high civilian casualties because of their close proximity to industrial/heavily populated areas. Moderate civilian casualties appear likely if Hanoi ([redacted]) and the Hon Gai [redacted] powerplants are hit. Strikes against the remaining facilities probably would cause light civilian casualties.

25X5

25X5

B. Manufacturing Plants

The majority of the manufacturing plants considered for attack are located within the greater Hanoi-Haiphong area and are located within fairly heavily populated areas. About 20,500 civilians will be at risk if all of the facilities in the Hanoi-Haiphong area are struck. Cumulative civilian casualties resulting from such an operation are estimated to range from 900 to 1,300.

III. The Mining Program

A limited mining operation directed against reducing seaborne imports carried by relatively deep-draft oceangoing ships could be carried out with a minimum number of casualties. This is particu-

larly true if the mines are equipped with delayed-action fuses that would provide ample time -- 48 hours -- for shipping to clear or to avoid Vietnamese ports.

The use of mines with a capability against shallow-draft coastal shipping and inland water craft would expose a much greater population to risk of injury. It is unlikely, however, that these casualties would be excessive. The experience of similar mining programs during World War II was that navigation of mined waters was soon stopped and other means of transport were adopted.

IV. The Attack Against Dikes and Locks

The breaching of the levee systems in the Hanoi area would not result in a large number of casualties. JCS pre-strike estimates of the number of casualties resulting from the actual bombing attacks do not exceed 200. This number could be less in view of the population's experience in taking shelter from air attacks. The number of casualties resulting from the flooding of adjacent areas would be even smaller. There is some prospect that North Vietnamese contingency planning and countermeasures, such as defensive breaching, would reduce the flood level. Moreover, the areas to be breached are areas in which flooding is not uncommon and housing is built to withstand high water levels, which would limit flood damage.

V. Unlimited Bombing

The major impact in terms of casualties from an unlimited bombing campaign against specific targets (including populated areas) would be in the military target system. If the campaign were extended to include all of the 39 unstruck JCS-designated military targets, the estimated military casualties would range from 10,000 to 13,000. Civilian casualties would be at about one-fifth this number.

The casualties resulting from possible unlimited bombing of economic targets such as pharmaceutical plants, food-processing plants, fertilizer plants, and textile plants would probably be of a higher order of magnitude than that estimated for the attack on the modern industrial target system outlined in Appendix B. A greater number of the industrial targets considered for an unlimited bombing program are located in densely populated parts of Hanoi and Haiphong. The

undertaking of an unlimited armed reconnaissance program against targets located in heavily populated areas also would probably result in a civilian casualty rate much higher than that obtaining in 1966.

VI. Interdiction of Route Packages 1 and 2, and Laos

The intensive bombing of the lower section of the "logistic funnel" would undoubtedly reduce the number of civilian casualties if the effort were restricted to logistics targets. It is estimated that over 8,000 civilian casualties were inflicted in Route Packages 1 and 2 during 1966. It is doubtful that this estimate would radically increase if the number of sorties and the amount of ordnance expended in the two lower route packages were to increase considerably. Both the sparse population in the rural areas of Ha Tinh and Quang Binh Provinces and adequate civilian defense measures seem to indicate that casualties would not drastically increase. The sparse population along the infiltration routes in Laos would also mean that there would be no dramatic increase in casualties there.

APPENDIX H

THE NORTH VIETNAMESE WILL TO PERSISTI. The Effect of the Present Program

The present Rolling Thunder program has not, as yet, produced any apparent weakening in Hanoi's will to persist. The North Vietnamese leaders continue to insist, both in public and private statements, that they are willing to withstand even heavier bomb damage rather than accept anything less than their often-stated demands for a settlement in Vietnam. Hanoi has been able to adjust its military and economic activities, which support its war objectives, to the bombing. Hence, while there may be some degree of escalation that would force the regime to reexamine its position, it is believed that as far as pressure from air attack is concerned, Hanoi would be prepared to continue the insurgency in South Vietnam indefinitely in the face of the current level and type of bombing program.

Available evidence on popular attitudes in North Vietnam indicates that Ho Chi Minh's regime still enjoys strong support and that the Hanoi leaders have been successful in adapting for their own ends the upsurge of national pride and identity created by the airstrikes.

This is not to say that there has been no slippage in public morale over the past two years. A strong note of fatalism is apparent

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25X1

the leadership has thus far been successful in focusing popular anger at the bombings on the United States.

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II. The General Effects of Escalation

There are two factors which are important to keep in mind in considering the effects of any escalated program of air attack:

a. The North Vietnamese leadership has been making an even greater effort than usual over the past two months to prepare the people of North Vietnam for further sacrifices during 1967. A series of year-end statements by regime leaders highlighted their

belief that the United States will continue, and expand, the program of airstrikes during the year. Speeches and articles by Premier Pham Van Dong, Party First Secretary Le Duan, and Defense Minister Giap in December and January predicted ultimate victory, but warned of further difficulties before victory could be achieved.

b. The will of the North Vietnamese to persist in the war depends not only on the effect of the airstrikes in the North but also on how they assess the war situation in South Vietnam. Hanoi undoubtedly realizes that its chances for a military victory in South Vietnam have vanished. In addition, the strains on the Communist side are great and are increasing. If, during 1967, the South Vietnamese government's pacification program makes steady progress and if Saigon continues to gain in stability, it is possible that Hanoi would reconsider its policy.

III. The Present Program Plus Electric Power and Major Industrial Facilities

While severe damage to the modern industrial sector would place additional pressures on the regime, it is not believed that the burden from air attack alone would be heavy enough to bring Hanoi to negotiate. The most relevant evidence -- the neutralization of much of the heavy industry in North Korea during the Korean War -- suggests that the burden would be bearable. While the continued loss of important economic facilities was undoubtedly a factor in Pyongyang's decision to negotiate, the major factors were the pressure of the ground war and the threat of further escalation of the air war. It is also evident that North Vietnam has already implemented measures designed to offset, as far as possible, many of the effects of intensified bombing. These measures include evacuation of personnel from urban areas, dispersal of some industrial equipment and supplies, and relocation of a few plants.

IV. The Mining of Haiphong In Addition To the Above Targets

The interdiction of the port of Haiphong would cause serious concern to the Hanoi leadership. Their reaction would depend on the effectiveness of the mining and the success of alternate methods of supply. As long as North Vietnam believes that it can receive essential supplies either by offloading seaborne supplies along the coast or overland through China, its resolve to fight on will probably remain.

There is no evidence that the current disorder in Communist China has thus far significantly interfered with the flow of vital supplies to North Vietnam. Should the situation inside China deteriorate to the extent that the supply of goods overland became unreliable, the North Vietnamese might be faced with the necessity of reconsidering their whole approach to the war. At the present, most of North Vietnam's military supplies come overland through China. The North Vietnamese could probably continue to supply the Viet Cong, the air defense system, and essential war-supporting activities in the North with supplies for a while, using current stock piles, even in the face of a reduced flow over Communist China's road and connecting rail system. However, should the logistic pinch become severe enough to deplete stocks in North Vietnam, the chances of a reexamination by Hanoi would increase markedly.

V. The Inclusion of Dikes and Locks on the Red River in the Above Targets

A gauge of how Hanoi would react to strikes on the dikes and locks along the Red River was provided during the 1966 flood season when the North Vietnamese appeared genuinely concerned that the United States intended to strike these targets. The North Vietnamese reaction at that time was to attempt to build alternate dikes, to organize work teams for the rapid repair of damaged dikes, and to evacuate people from low-lying urban areas close to the Red River.

As in other instances, the impact on North Vietnam's will to persist would depend on: (1) the damage done by the strikes and the effectiveness of the regime's efforts to offset such damage, and (2) Hanoi's ability to obtain food from China and the USSR to offset the loss of the rice crop. The Hanoi leaders probably believe that North Vietnam can localize damage from attacks on the dike system. Even if such attacks should result in extensive damage to the October/November rice harvest and significant civilian casualties, there is no reason to believe that the leadership in Hanoi will call off the war in the south. A rationing system, in all likelihood already devised, would probably assure adequate food for the military forces, government cadres, and key industrial workers. Moreover, the North Vietnamese would certainly exploit the golden opportunity presented by such losses in their propaganda effort to put intense political pressure on the United States.

VI. Unlimited Bombing, Except Population Centers

Air attacks on the miscellaneous industrial and repair facilities in the "unlimited" package would probably bring only marginal additional pressure on Hanoi. However, as noted under V above, the most likely bombing pressure to force Hanoi to reexamine its position would be the denial of essential war-supporting supplies and equipment currently flowing in from the USSR, China, and other Communist countries. Should the attack on the key rail and road (including inland waterway) connections to China succeed in materially reducing the flow of supplies -- economic as well as military -- which Hanoi needs to support its activities, a major reconsideration of the insurgency would probably be forced on it.

VII. Striking Only Routes 1 and 2 Plus Laos

Hanoi would regard the limitation of US airstrikes to these areas, the so-called "logistic funnel," as a clear victory, demonstrating that political pressures on the United States as a result of reaction to propaganda claims about civilian casualties inflicted further north had been effective. The regime would be encouraged in its belief that the United States will ultimately tire of the war. The North Vietnamese would almost certainly not accept the limitation of the airstrikes as a gesture toward deescalation, but as a sign that its policy was forcing the United States to retreat.

The effect of concentrating US airstrikes on the infiltration and supply route complex would be further blunted by the fact that Hanoi may have already decided to slow down the infiltration of regular North Vietnamese units to South Vietnam. It appears to have decided not to attempt, in 1967, a buildup of regular forces in the south on the same scale as in 1965-66. In addition, both the recent activity of the Communists on the ground and their published statements on military tactics and strategy indicate that Hanoi may have decided to intensify, at least for the time being, guerrilla tactics rather than to expand further its capability for large unit actions.

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